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A NEW TECHNIQUE AND DOSAGE SYSTEM FOR GAMMA RAY THERAPY IN SURFACE APPLICATION OF RADIUM[1]

by

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In practical radium therapy the main physical problems are the quantity of radium required, the method of distribution and the necessary treatment time for a desired dose. Mathematical calculations of the intensity of radiation may solve these problems. If the arrangement of radium on surface applicators is standardized all these questions are simpler of solution, the calculations then being done beforehand. This article is essentially a description of such a technique in the application of radium utilizing a short radium-skin distance and relatively small areas and giving radiation of known physical intensity.

This technique, based on mathematical calculation, has been developed by the author in collaboration with the physicist Dr. BENNER of the radiophysical department and perfected at the Radiumhemmet since January 1936. The principle of the arrangement makes use of standard applicators consisting of individual glass capsules for each radium tube by means of which the tubes are always fixed at exactly the same distance from each other and from the surface of the skin. Thus the intensity of the γ-radiation from every applicator can be previously determined and the treatment time for any desired dose can be read off directly from a dosage chart.

The article consists of three parts:

1. Calculation of intensity.
2. Description of applicator.
3. System of dosage.

[1] Preliminary report presented at the meating of the Swedish Society for Medical Radiology, Oct. 1936. Also read as an introduction to the paper »Radium Treatment of Cavernous Haemangiomas» at the Congress of the Northern Association for Medical Radiology in Copenhagen, June 1938.

(From Radiumhemmet, Stockholm. Chief: Professor ELIS G. BERVEN, M. D.)

1. Calculation of Intensity

Unit of intensity.

The unit of radiation intensity chosen is the r unit per hour, and a value of 7.5 r per hour is accepted as the intensity of radiation at a distance of one centimeter from a one milligram point source of radium which is filtered by 0.5 mm of platinum. This intensity is equivalent to one *Imc*-unit, i.e., the γ-ray unit defined by SIEVERT (14). This value, 7.5 r per hour equivalent to 1 *Imc*, has been determined and previously discussed by SIEVERT in Acta Radiologica 1934 (SIEVERT, 15).

Mathematical calculation.

The formula given by SIEVERT for the calculation of the intensity of the γ-radiation from rod shaped radium preparations (SIEVERT, 10, 11), is simple to use in practice. Once the principle is understood, it is not so complex as it first appears. The calculation of the intensity in r per hour at a point X, a certain distance from the center Y of the axis of such a preparation (Fig. 1 *A*), is derived from the equation

$$I = k \cdot \frac{2P}{l} \cdot \frac{F(\varphi, A)}{a};$$

where

P = radium quantity in milligram.
l = active length of radium in centimeters.
a = distance of X from center Y of the axis in centimeters,
k = a constant factor including both the value 7.5 r per hour mentioned above, and a correction factor $\frac{1}{0.905}$ for the values given in SIEVERT's diagrams and tables (SIEVERT, 10, 11), which are calculated for unfiltered γ-rays. Thus k is $\frac{7.5}{0.905} = 8.29$.
A = a constant for the preparation in question, dependent upon the wall filtration. If the different materials in the wall have respective thicknesses of d_1, d_2, d_3, ... cm, and their coefficients of absorption are respectively μ_1, μ_2, μ_3, ... the factor $A = d_1\mu_1 + d_2\mu_2 + d_3\mu_3 \ldots\ldots$
φ = the angle between an axis perpendicular to the preparation axis, and a line from the point X to one end, Z, of the enclosed radium column.
$F(\varphi, A)$ = a function of φ and A defined and tabulated by SIEVERT (10, 11).

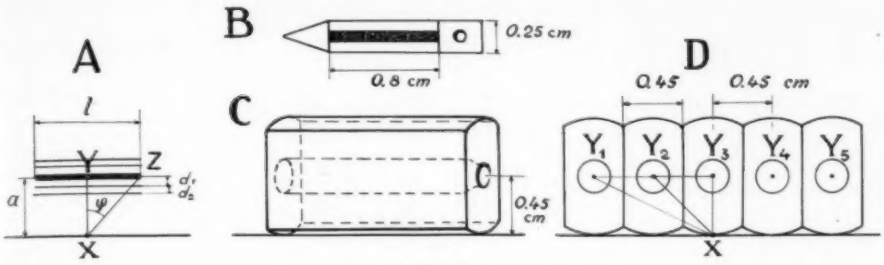

Fig. 1.

A. Rod shaped radium preparation
l = active length of radium
a = distance between center Y of the axis and surface to be treated. X = center of the surface. Z = end of enclosed radium column.
φ = angle between the lines XY and XZ.
B. Dimensions of a 10 mg radium needle used at the Radiumhemmet.
C. Dimensions of glass capsule for such a needle. Length = 15 mm.
D. Five capsules placed tightly together. Y_1—Y_5 = center of each needle.

The equation consists of two factors: $k\frac{2P}{l}$ is constant for the preparation in question and $\frac{F(\varphi, A)}{a}$ is variable. The former part as well as the constant A may be definitely calculated for each preparation and the actual problem only is to calculate the variable $\frac{F(\varphi, A)}{a}$. In each case the angle φ is defined by $\tan \varphi = \frac{l}{2a}$. Thus when the values of A and $\tan \varphi$ are known, the function $F(\varphi, A)$ is simply obtained in the tables given by SIEVERT (10, 11) and is then divided by a.

If the intensity is to be calculated at points not lying on the perpendicular through the center of the radium column, the above equation should be used in the somewhat more complicated shape given originally by SIEVERT.

Example.

The most common type of radium preparations used at the Radiumhemmet is a needle with a diameter of 0.25 cm containing 10 mg of radium, with an active length of 0.8 cm and with a wall filtration of 0.02 cm Au + 0.035 cm Pt, equivalent to 0.5 mm Pt (Fig. 1 *B*). In this

example $k = 8.29$, $P = 10$ and $l = 0.8$. The constant part of the equation of the intensity is $\frac{k \cdot 2P}{l} = \frac{8.29 \times 2 \times 10}{0.8} = 207.2$ and the constant factor $A = d_1\mu_1 + d_2\mu_2 = 0.02 \times 1.9 + 0.035 \times 2.0 = 0.11$. Thus the equation of the intensity of that needle is

$$I = 207.2 \frac{F(\varphi, 0.11)}{a};$$

If now the intensity in r per hour is calculated at a point X a distance of 0.45 cm from the center Y of the axis of such a needle, only the variable $\frac{F(\varphi, 0.11)}{0.45}$ need be determined. The angle is defined by $\tan \varphi = \frac{l}{2a}$ where $l = 0.8$ and $a = 0.45$. Tan $\varphi = \frac{0.8}{2 \times 0.45} = 0.889$. When knowing the factors $A = 0.11$ and $\tan \varphi = 0.889$, the function $F(\varphi, A) = 0.648$ is obtained in SIEVERT's tables. Then the intensity at point X is $I = 207.2 \frac{0.648}{0.45}$, that is, approximately 300 r per hour.

Intensity curve (depth dose curve).

In the same manner the intensity may be calculated at any point on a line perpendicular to the axis of the radium needle through its center. If the different values of the intensity are referred to a right angled co-ordinate system (Fig. 2) where the distance is plotted in millimeters on the x-axis and the intensity in r per hour on the y-axis, then the resultant curve drawn will show the intensity distribution of the γ-radiation from the radium needle along the line mentioned above. Fig. 2 *A* shows the intensity curve for the 10 mg radium needle at the Radiumhemmet (Fig. 1 *B*), derived from calculations by Dr. BENNER who has also measured the intensity at different points with condenser chambers of the SIEVERT type (SIEVERT, 13, 16). The values calculated mathematically and measured physically agree exceedingly well. The curve is applicable if the radium needle is surrounded by organic tissue or other light materials, as for instance, glass, the absorption in these being almost compensated by secondary radiation.

Distance and depth dose.

It is very important to observe the enormous variation of the intensity in the immediate vicinity of the radium needle (Fig. 2 *A*). At a distance of 2.5 mm from the center of the axis of the radium column the intensity is about 750 r per hour and at a distance of 4.5 mm only

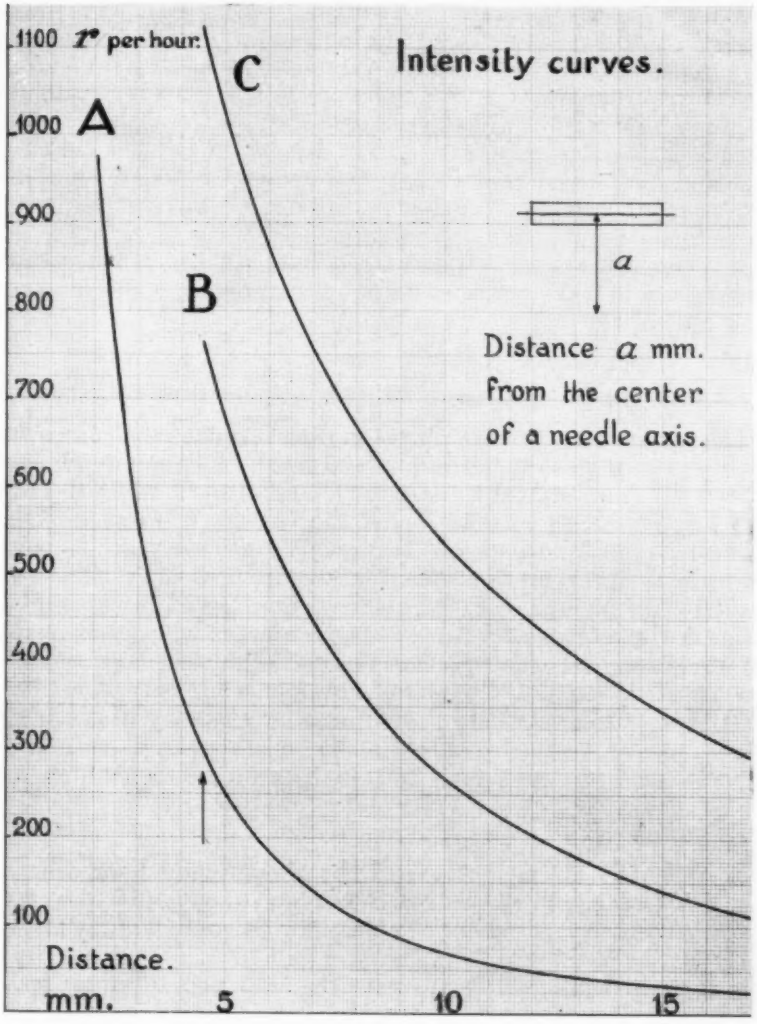

Fig. 2.

Intensity distribution along a line perpendicular to the needle axis at different distances from the center of

A one 10 mg radium needle
B the middle needle in an applicator of five capsules in one row
C a middle needle in an applicator of twenty capsules in two rows.

300 *r* per hour. Thus, an increase of 2 mm in the distance reduces the intensity to 40 per cent. This may explain why over- or underdosage rather frequently occurs in surface application of radium at a short distance when moulded compound applicators are employed. With plastic mass it is impossible to measure exactly the distance in millimeters between the radium needles and between the radium and the skin. The curve also shows that an increase in the radium-skin distance to only 4.5 mm results in a great improvement of the relative depth dose without sacrificing much in surface intensity (Fig. 2 *A*). If the distance between the radium and the skin is fixed at 4.5 mm the surface intensity is 300 *r* per hour and at 2 mm depth, 158 *r* per hour or 53 per cent of the surface intensity.

Contact radiation (clinical considerations).

If the radium needles are placed in direct contact with the skin the intensity is very great at the surface and rapidly falls at a depth of a few millimeters. A superficial tumour may be destroyed while the normal tissue below remains intact. But if the tumour has any appreciable thickness it would be impossible to give the deeper portions a heavy dose without damaging the normal tissues both in the depth and surrounding the tumour. For many surface treatments, for example, the treatment of cavernous haemangiomas, the deeper lying portions should have a relatively large dose, but at the same time the surface must not be overtreated. An extreme difference between surface and depth dose should therefore be avoided in radium surface therapy of such lesions.

2. Description of applicator

Glass capsules.

To utilize all the advantages of the above method for calculation of the intensity of the γ-radiation, a new type of capsule for our radium needles have been devised in order that the radium will always lie at an exactly constant distance from the skin and the different needles at a constant mutual distance from each other. The capsules are made of thick walled glass capillary tubes which have been flattened by grinding the two sides which are to be placed in apposition. The inner diameter of the capillary tube is chosen for the radium needle in question and the outer radius measures the distance between the needle axis and the skin. The thickness of each capsule determines the distance between the individual radium needles when the capsules are placed in contact with each other (Fig. 1 *D*).

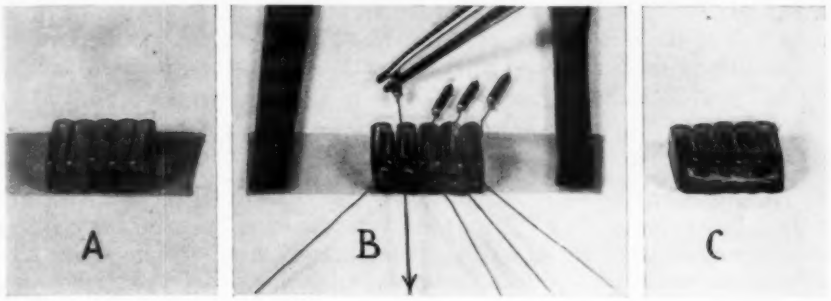

Fig. 3.

Photograph showing the steps in the preparation of an applicator.

A Empty capsules placed on cellulose adhesive tape
B Filling of capsules with radium needles
C Applicator ready for use.

Dimensions of capsule.

Two different types of such capsules have been tried at the Radiumhemmet. One type (Fig. 1 *C*) is designed for a needle containing 10 mg of radium, the external dimensions being 15 × 2.5 mm. The distance between the axis of the radium and the surface of the capsule, and thus to the skin, is 4.5 mm and the distance between two needles 4.5 mm. These values have proved convenient to give relatively homogeneous radiation. The other type is made for a tube containing 8 mg of radium with an active length of 15 mm, the external dimensions being 20 × 2.8 mm. The distance between the axis of the radium and the surface of the capsule is 4.5 mm and the distance between two tubes 5 mm.

Applicator of capsules.

When a glass capsule is to be filled, a thread is tied to the eyelet of a radium needle, the free end pulled through the capsule, and the radium needle drawn into it. The lumen of the capsule is slightly narrowed at the opposite end, thus preventing the radium needle from slipping out. When the thread is pulled taut, the needle is fixed in position.

The applicator is composed of the number of capsules required by the size of the area to be treated. The empty capsules are first placed on cellulose adhesive tape and all are filled at one time (Fig. 3 *A*, *B*); the threads of the needles are then pulled taut and knotted at the narrow end of the capsules; finally the cellulose tape is wrapped around and the applicator is ready for use (Fig. 3 *C*). This packing of the radium needles

in the glass capsules can be done entirely with instruments and with little risk of damage to the fingers. Many of the lesions to be treated are similar in size and shape so that standard boxes can be used instead of groups of capsules.

Glass as material.

The capsules are composed of glass. Biological and physical investigations have shown that the secondary β-radiation from primary filters is better eliminated by secondary filters of substances of medium atomic number than of lighter (BENNER 1, with bibliography, BENNER and SNELLMAN 3, MOTTRAM 7, SUETSUGO and BRAUN 20). Other investigators did not find appreciable differences in biological effect (STAHEL 18, 19, STAHEL, SIMON and JOHNER, 17). Although glass is not an ideal secondary filter for γ-radiation it is still better than the organic substances usually employed. Glass has many other advantages; it is of constant shape, is easy to prepare in the prescribed size, its transparency simplifies application and it is simple to clean and sterilize.

Intensity of radiation at surface of capsules.

If five needles, Y_1, Y_2, Y_3, Y_4, Y_5 (Fig. 1 *D*), each containing 10 mg of radium, are packed in glass capsules fixed tightly together, the intensity of the γ-radiation at the center X of the surface of the applicator is obtained by adding the intensity from each of the needles. The distance from the center of middle needle Y_3 to the surface of its capsule is 4.5 mm. The curve *A* in Fig. 2 gives the values of the intensity of radiation. The intensity at a distance of 4.5 mm from the center of the needle is 300 *r* per hour. The distance from the center of an adjacent needle Y_2 to the same point X, can easily be calculated according to the Pythagorean proposition. This distance is a hypotenuse in a right-angled triangle where the base is the distance between the two radium needles Y_2 and Y_3 and the perpendicular the distance between the middle needle Y_3 and the surface point X, each equivalent to 4.5 mm. Thus the sought distance is $4.5\sqrt{2} = 6.4$ mm. In the curve *A* in Fig. 2 the intensity at this distance from the center of the needle is found to be 160 *r* per hour. In the same manner the intensity from needle Y_1 to point X is found to be 65 *r* per hour. The total intensity at point X thus is $300 + 2 \times 160 + 2 \times 65 = 750$ *r* per hour.

Intensity at different points of applicator.

The surface intensity has been determined for practically all applicators at the Radiumhemmet by Dr. BENNER and assembled in table

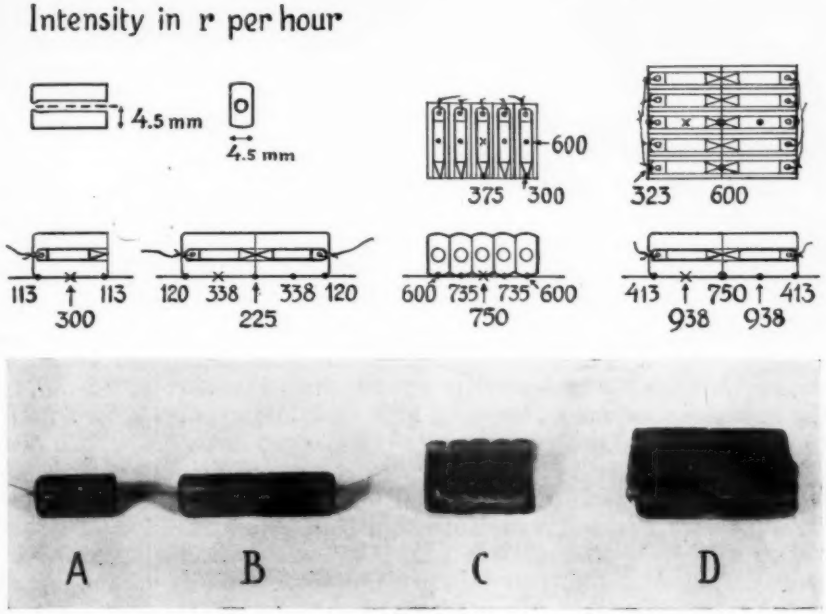

Fig. 4.

Upper: Intensity of γ-radiation in r per hour at different points on the surface of applicators *A*, *B*, *C*, *D*. Point of maximum intensity marked $\times$.

Lower: Photograph of

A one glass capsule with radium needle of 15 mm length
B two capsules end to end
C applicator consisting of five capsules in one row
D applicator consisting of ten capsules in two rows.

form. These tables show the intensity both at the center of the surface of the applicator and at the point of maximum intensity if this is not the center. The applicator should be of sufficient size so that the radium covers an area a few millimeters larger than that to be treated, thus making the difference between the intensity at the center and at the periphery of the lesion negligible.

Fig. 4 shows a number of applicators of which the intensity of the γ-radiation is calculated at different points on the surface. In the treatment of benign lesions, especially cavernous haemangiomas, it is important not to overdose and consequently it is advisable only to calculate the maximum intensity. In the treatment of malignant tumours,

as basal cell carcinomas, it is essential not to undertreat and therefore it is advisable to calculate the minimum intensity which would be at the periphery.

3. Dosage system

Surface and depth dose.

Clinical investigations suggest that the depth dose is of great importance for the effect at the surface. This may be illustrated by the following examples.

The maximum surface intensity of the γ-radiation has been calculated for three different applicators at a central point and at different distances from the center. These applicators are: one needle containing 10 mg of radium in its glass capsule, five such needles fixed together in one row and twenty such needles in two rows of ten. (Fig. 2 *A*, *B*, *C*) The maximum surface intensity for 1 needle is 300 *r* per hour, for 5 needles 750 *r* per hour and for 20 needles 1,125 *r* per hour. A surface dose of 1,875 *r* per hour requires a treatment time of $6^1/_4$ hours with one needle, $2^1/_2$ hours with 5 needles, and $1^2/_3$ hours with 20 needles. Clinical experience has shown that the skin reaction produced by 1 needle is very slight, by 5 needles slight, resulting in an erythema and by 20 needles moderate with a mild dry epidermitis. This may be explained by the very different depth doses of these three applicators; the curves of the depth doses are reproduced in Fig. 2. At a depth of 12 mm from the surface the intensity with one needle is 30 *r* per hour, with 5 needles 120 *r* per hour and with 20 needles 307 *r* per hour, that is 10 %, 16 % and 27 % of the respective surface intensities. Thus the depth dose at 12 mm produced by 20 needles is approximately 3 times that produced by 1 needle in spite of the surface dose being the same. This is such a great difference that it does not correspond to the relatively moderate difference in biological effect to the skin. If the same calculation is repeated at a depth of 5 mm the depth dose produced by 20 needles is twice that of 1 needle. This is in better correspondence to the skin reaction.

Average of depth intensity.

The judgment of dosage in surface therapy is based on the biological effect of the radiation to the skin but the skin reaction is dependent on the dose not only at the surface, but also at a depth corresponding to the immediate layers of underlying tissues. Clinical experience has shown that conformity between dosage and skin reaction will be found if the dose has been calculated in accordance with the average of the intensity at a central surface point and at each successive point down to a depth

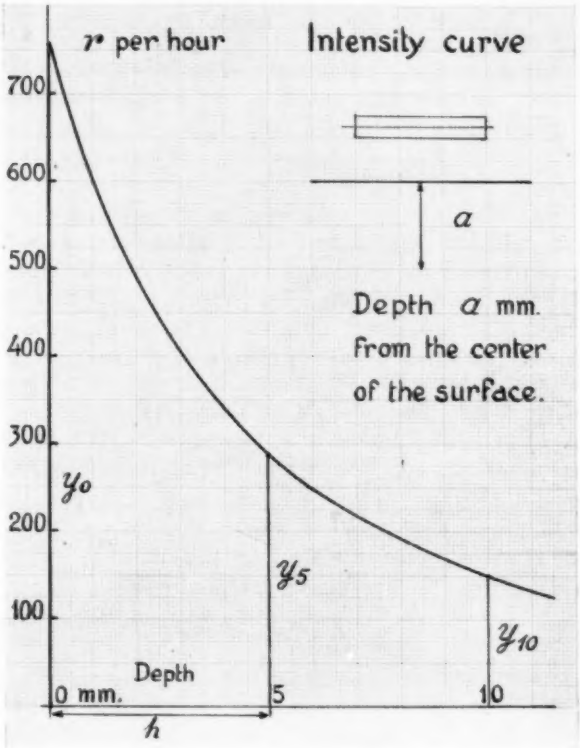

Fig. 5.

Intensity distribution at different distances from the surface of an applicator consisting of 5 glass capsules with needles. (The same curve as in Fig. 2 *A*, if the y-axis is placed at point $x = 4.5$) The ordinates y_0, y_5, y_{10} are marked.

of 1 cm. One of the fundamental rules for dosage in surface therapy therefore should be: *The dose should not be calculated according to the surface intensity but to the »average intensity» from the surface to a depth of 1 cm.* An acceptable formula for taking this average of the intensity is derived as follows.

Rule for taking average of intensity.

The intensity of the γ-radiation has been calculated for plaques of one to 32 radium needles placed in one or two rows. This has been done along an axis perpendicular to the plane of the needles and through

the center of a middle needle. The first value y_0 has been calculated at a distance of 4.5 mm from the center of the needle, this corresponding to the surface of its glass capsule. Ten other values, y_1—y_{10}, have been calculated, namely the intensity at each successive millimeter from the surface to a depth of 1 cm. The average of these 11 values is $\frac{y_0 + y_2 \cdots + y_{10}}{11}$ (fig. 5). A more accurate result would be obtained if the average were taken of an infinite number of intensity values, that is, if the integral of the intensity for the interval $x = 0$ to $x = 10$ were calculated and divided by the length of the interval. This is the same as dividing the surface S bounded by the curve, the two ordinates y_0, y_{10} and the x-axis by the base; the result is equal to the average height of that surface. The calculation of the surface S may be performed by using SIMPSON's formula, but may be simplified without too large an approximation by using CÔTE's formula (MALMQUIST, 4). The base x_0—x_{10} (Fig. 5) is then divided into two equal parts, h, and the three ordinates y_0, y_5 and y_{10} are inserted in CÔTE's formula.

$$S = \frac{h}{3}(y_0 + 4\ y_5 + y_{10}).$$

Dividing this surface S by the base $2\ h$ the average height y_h is obtained

$$y_h = \frac{y_0 + 4y_5 + y_{10}}{6}.$$

This is then the same as the formula for the calculation of the average of the intensity I_h at the surface of the skin and at each successive point down to a depth of 1 cm.

$$I_h = \frac{I_0 + 4\ I_5 + I_{10}}{6};$$

where I_0 = surface intensity
I_5 = intensity at a depth of 5 mm
I_{10} = intensity at a depth of 10 mm

The rule thus is: The »average intensity» in a tissue layer of 1 cm thickness is equal to the sum of the surface intensity, four times the intensity at a depth of 5 mm and the intensity at a depth of 10 mm, divided by 6. This rule can be correctly applied to any method of radiation therapy, be it with radium or röntgen.

Comparing calculations according to SIMPSON's and CÔTE's formulas for the intensity of different applicators demonstrates that the values obtained by CÔTE's formula are sufficiently accurate. Thus it is only

necessary to calculate the intensity I_0, I_5 and I_{10} at three different points for each applicator, this being done by the use of SIEVERT's formula mentioned above, to obtain the *»average intensity»*.

Example.

The numerical value of the average of the intensity from the surface to a depth of 1 cm with five 10 mg radium needles in an applicator of glass capsules, is calculated in this manner. The intensity curve is drawn in Fig. 5. The intensity at the surface is $I_0 = 750$ at a depth of 5 mm $I_5 = 285$ and at a depth of 10 mm $I_{10} = 150$. Then the *»average intensity»* is

$$I_A = \frac{750 + 4 \times 285 + 150}{6} = 340 \ r \text{ per hour.}$$

Treatment time and »average intensity».

The above *»average intensity»* has been determined and tabulated for all our applicators of radium needles in glass capsules. By utilizing this *»average intensity»* the same *»average dose»* can be given by all applicators to produce the same reaction. 1 needle gives an *»average intensity»* of 110 *r* per hour, 5 needles 340 *r* per hour and 20 needles 625 *r* per hour. Clinical investigations have shown that a treatment time of 2.5 hours is suitable for 5 needles to produce a slight erythema of the skin. According to the *»average intensity»* this makes an *»average dose»* from the surface to a depth of 1 cm of $2.5 \times 340 = 850$ *r*. In order to obtain the same *»average dose»* with the other applicators the treatment time will be for 1 needle $\frac{850}{110} = 7^3/_4$ hours and for 20 needles $\frac{850}{625} = 1^1/_3$ hours. These times correspond extremely well to those empirically found to produce the same skin reaction. In general the following may be taken as an average of the reaction to be expected. 1,500—1,600 *r* cause a dry epidermitis of the skin and 1,800—2,000 *r* an exudative epidermitis. Lesions such as cavernous haemangiomas disappear with cosmetic restoration with a single treatment of an *»average dose»* of 700—850 *r*. Superficial basal cell carcinomas of a few millimeters' thickness disappear with a single treatment of an *»average dose»* of 1,850—2,000 *r*.

It is interesting to find that these *»average doses»* of γ-radiation are of approximately the same values as the *»average doses»* ordinarily used in röntgen therapy. Further investigations of the use of the *»average intensity»* (in the superficial tissue layer) as the basis for calculation of treatment times in all radiological surface therapy will be published

at a later date. Clinical experiences with a material of 300 cases of cavernous haemangiomas treated according to this method will be published in the next issue of this journal.

SUMMARY

A correlation of standardized arrangements of radium in applicators of glass capsules of constant size with a special dosage calculation constitutes what is here called a new technique and dosage system for γ-ray therapy in surface application of radium. The size of the area to be treated decides the size of the applicator and thus the number of the glass capsules; as a result the number of radium tubes and their arrangement are fixed. Thus each applicator gives radiation of known physical intensity. The average of the intensity at the surface and at each successive point to a depth of 1 cm has been determined according to a formula derived. If the same »*average dose*», calculated from this »*average intensity*», is given with each applicator, the biological effect is found to be the same.

It is interesting to find that these »*average doses*» of γ-radiation are of approximately the same values as the »*average doses*» ordinarily used in röntgen therapy.

ZUSAMMENFASSUNG

Eine neue Technik und Dosierungsweise in der Oberflächentherapie mit γ-Strahlen wird hier beschrieben. Die Anordnung der Radiumpräparate an die Haut ist dadurch standardisiert worden, dass die Radiumnadeln in Applikatoren, die aus Glaskapseln von konstantem Mass bestehen, fixiert werden. Die Grösse der Fläche die behandelt werden soll bestimmt die Grösse des Applikators und somit auch die Anzahl der Glaskapseln und ihre Anordnung. Dieser Standardisierung zufolge kann man die Intensität der γ-Strahlung für jeden Applikator im voraus berechnen. Der Mittelwert der Intensität von der Hautoberfläche bis zu einer Tiefe von 1 cm ist berechnet nach einer hergel i et n Formel. Infolge dieser »*Mittelintensität*» kann man dieselbe »*Mitteldosis*» mit jedem Applikator geben und eine gleiche biologische Wirkung erhalten.

Es ist interessant zu konstatieren, dass di se »*Mitteldosen*» der γ-Strahlen etwa dieselben Werte haben wie die »*Mitteldosen*» in der allgemeinen Röntgentherapie.

RÉSUMÉ

Cet article traite une technique et une méthode nouvelle de dosage pour la thérapie des rayons γ quand le radium est appliqué sur la peau. La nouvelle technique consiste en un arrangement standardisé du radium dans des applicateurs de capsules en verre de mesure constante. La grandeur de la surface qui doit être traitée détermine la grandeur de l'applicateur et par conséquent le nombre des capsules ainsi que le nombre des préparations du radium et leurs arrangements. Grace à ce règlement l'intensité du rayonnement peut être calculée d'avance pour tous les applicateurs. La moyenne de l'intensité du rayonnement de la surface de la peau jusqu'à un centimètre de profondeur est calculée d'après une formule derivée. Avec cette »*intensité moyenne*» pour le calcul des dosages il est donc possible de donner la même »*dose moyenne*» avec chaque applicateur spécial pour obtenir le même effet biologique.

Il est intéressant de constater que ces »*doses moyennes*» des rayons γ ont approximativement les mêmes valeurs que les »*doses moyennes*» généralement employées dans la thérapie des rayons X.

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ROENTGEN FINDINGS IN SO-CALLED URETHRAL CAVERNOMA[1]

by

Bo Stenström

Changes in the anterior portion of the urethra generally found on roentgen examinations by contrast injections have an inflammatory or traumatic origin. In other words it is generally a question of urethritis or rupture or else changes resulting from such conditions, i.e. strictures. In a patient on whom urethrography was recently carried out at Maria Hospital in Stockholm a condition was however found which, as far as I have been able to find, has not earlier been described in the roentgen literature; a brief record of same would therefore seem justified.

The case is that of a man, aged 25, who one morning about 12 months previously noticed that he had some urethral bleeding during the night. On urination he found the first lot to contain blood. He was not troubled with any burning sensations and there was no urgent call to micturition. He remembered having sustained, a few days earlier, a mild blow to the genetalia. The doctor he consulted could find no explanation of the bleeding.

At midsummer this year the patient again noticed on three different occasions similar bleeding, always discovered in the morning. On these occasions he also noticed slight frequency of micturition.

On Sept. 9 there was again some bleeding, this time of longer duration. It kept on even in the day-time, necessitating a dressing to be applied. The bleeding seemed to be more copious when the patient was in sitting position.

He was then admitted to a local hospital. The bleeding ceased. Urethrography was also carried out there but no cause of the bleeding could be discovered on the films. This may possibly have been due to insufficient definition of the pictures.

[1] Submitted for publication, Dec. 22, 1938.

The patient was admitted to Maria Hospital on Oct. 3. From the clinical report it may be stated that nothing pathological could be found in heart or lungs, nothing abnormal was found on palpating the abdomen and on rectal examination the prostatic gland was found to be normal. Nor was anything abnormal felt at the site of the seminal vesicles. No bleeding from the urethra. Examination of the urine proved negative. On Oct. 4 *urethrography* (Fig. 1.) was carried out by KNUTSSON's method. On injecting thorotrast the entire urethra was filled. In the anterior portion about 5 cm. from the external orifice in the upper wall, within a distance of about 2 cm., the normal even outline was not to be seen as in the adjacent surroundings but an uneven somewhat wave-like contour. There was no real narrowing of the lumen and beyond the above there was nothing of note to be seen in the anterior part. Within the posterior portion there was a certain tendency to contraction but the collicle relief could be well observed and after the injection the posterior part contracted normally. The increased contractile tendency was regarded as a sign of some irritable condition of the posterior portion. The bladder shadow showed nothing of note. Considering the roentgen findings and the clinical history of the patient — hæmorrhage independent of micturition, thus coming from somewhere within the urinary tract on the distal side of the bladder — it was regarded as likely that the above-mentioned change in the urethral outline was due to some pathological process which gave rise to the bleeding.

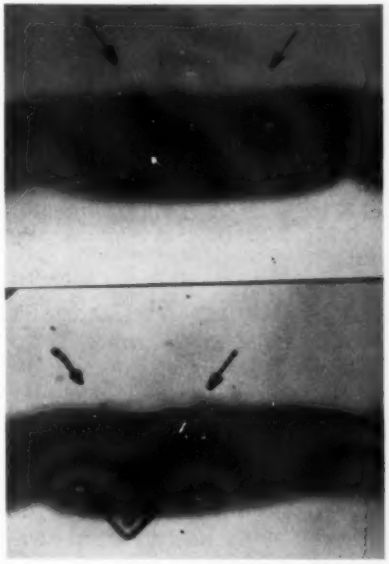

Fig. 1. On the dorsal side of the urethra there is a minutely wave-like irregularity in the outline.

The following day *urethroscopy* was carried out (Dr. HELLSTRÖM). One then found in the anterior portion on the right side slightly raised dark-red patches, varicose veins. These were coagulated. On the next day urethroscopy was carried out by LICHTENBERG's resectoscope. Marks of the coagulated veins were then seen besides a few more.

The patient was discharged to be kept under observation by the hospital where he had first been admitted.

Of the condition dealt with here, bleeding varices in the urethra, only relatively few cases seem to be described in the literature. The diagnosis has been made through urethroscopy. Roentgen examination, on the other hand, has not been the means of revealing the varices in the cases described. FISCHL, observing a case at autopsy in 1932, states that the condition has only been described 13 times. As pointed

Fig. 2 A. Diagrammatic drawing (magnified) of a chronic urethritis with filling of MORGAGNI's lacunae and LITTRÈ's passages.

Fig. 2 B. Diagrammatic drawing (magnified) of the altered lumen in the case described.

out by SCHOLL and BRAASCH the patients have generally been males. However, cases of similar changes in the female urethra have also been described by e. g. KALO and FRANKENTHAL. DEMEL is pointing out that the changes are often found about 6 cm. from the external orifice. They are often discovered on the dorsal aspect but have also been found on the lower side of the urethra (MULZER).

The symptom by which the pathological process has made itself known has nearly always, as in my own case, been bleeding from the urethra independent of micturition. In cases described by MULZER and DEMEL blood could be expelled by pressure on the urethra. HAJEK points out that urinary difficulties may arise if the varicose formations attain a certain size.

As to the patho-anatomical character of the condition opinions vary as to whether the changes should be considered of varicose or angiomatous nature. DEMEL, SEIFERT besides others hold that since similar changes in the bladder and the prostatic region are regarded as varices, these processes in the anterior portion of the urethra should also be so named. A good many other authors, on the other hand, such as MULZER, FROGUE-JEANBREAU, ISRAEL, KALO, FRANKENTHAL, RITTER & RATTNER, KLOTZ, SCHOLL and BRAASCH and finally FISCHL, all maintain that we are here dealing with hæmangioma. The last-mentioned author who is one of the few that have had the opportunity of examining under the microscope changes of this nature is of the opinion that it is a question of angiocavernoma. He thinks they arise as malformations. LANGER who has had to deal with the same case as ISRAEL be-

lieves in the possibility of a composite formation of lymph- and hæmangioma or cysts in which bleeding from varicose vessels off and on takes place. A theory of arterio-venous aneurysm has also been put forth.

As to treatment it is generally agreed that the varicose parts should be electrocoagulated. Such cauterisation has had several times to be repeated on account of recurrent hæmorrhage.

Finally, a few words about the roentgenological differential diagnosis. In the first place there is then *chronic urethritis* to be considered. Such change, too, appears as a minutely jagged irregularity of the contour, an irregularity however which generally is not confined to any local process but usually occupies the whole of the anterior portion of the urethra; this generally also shows a diffusely diminished lumen. In the anterior portion of the urethra we find not only the so-called MORGAGNI's lacunae, small depressions usually located on the dorsal side and the openings of which are directed forwards but also LITTRE's glands which form ramyfying passages into the corpora cavernosa. After an inflammatory process shrinkage may take place of the surroundings of these lacunae and glands with the result that their exits come to stand widely open into the urethral lumen. This means that on injection of opaque substance the lacunae and glands will be filled, an event that does not take place under normal conditions. KNUTSSON refers to this change in the contour as lacunar. In my own case the pathoanatomical basis of the altered outline is quite a different one. Here it is a question of a process with dilated vessels somewhat bulging into the urethra, forming a more evenly wave-like outline. Diagrammatically I have tried to show the difference between these two kinds of changes in the radiogram (fig. 2). A *polypus* ought to present a different appearance; a definite localised narrowing of the lumen and a more rounded contrast defect. True that *carcinoma* is also described as occurring in the anterior part of the urethra, even in young persons, but it is a very rare condition. A process of this nature is likely to give rise to quite a different roentgenological appearance than that described here. I have been unable however to find any roentgen picture of cancer of the anterior portion of the urethra in the literature. *Sarcoma* has also been described but the clinical course in these malignant processes has been quite different to that we are dealing with here, with metastases, with the general condition affected, difficulty in micturition and so on. Finally has also infiltration of the anterior portion of the urethra been found on urethroscopy in *leukaemia*. Here too the clinical data would seem to settle the diagnosis.

From the aforesaid it is clear that opinions regarding the morbid anatomy of the condition in question seem to be somewhat at variance.

The object of my contributing a clinical case is not to take up a position in reference to that side of the matter — this can only be done by microscopical examination — but to draw attention to the fact that the changes can be demonstrated through urethrography. A matter of particular importance here would seem to be the use of as sharp pictures as possible, since otherwise the undoubtedly as a rule insignificant altered outline cannot be seen. As also the pathological process occupies only a small area of the urethral wall it is of importance that the rays should strike the wall tangentially; it may even be necessary to take pictures with the syringe and thereby the urethra somewhat rotated in different directions.

SUMMARY

The author describes a case of bleeding from the urethra independent of micturition. The patient was a male aged 25. On urethrography was discovered, about 5 cm. from the external orifice, a change in the outline, 2 cm. in length, in the anterior portion of the urethra. On urethroscopy one found here varicose vessels which were coagulated. The author relates similar cases earlier described in the literature and states that such changes have not apparently so far been roentgenologically demonstrated.

ZUSAMMENFASSUNG

Verf. berichtet über einen Fall, bei dem Blutung aus der Urethra unabhängig von der Harnentleerung auftrat. Pat. war ein 25jähriger Mann. Bei Urethrographie sah man ungefähr 5 cm vom Orificium externum eine 2 cm. lange Konturveränderung in der Pars ant. Bei Urethroskopie wurden an dieser Stelle variköse Gefässe gefunden, die dann koaguliert wurden. Verf. referiert ähnliche früher in der Literatur angeführte Fälle und hebt hervor, dass bisher noch keine solchen Veränderungen röntgenologisch nachgewiesen worden waren.

RÉSUMÉ

L'auteur rend compte d'un cas d'hémorragie de l'urètre, indépendant de l'émission d'urine. Le sujet était un homme âgé de 25 ans. A l'urétrographie, on découvrit à env. 5 cm de l'orifice externe une altération de contour d'env. 2 cm de long dans la partie antérieure. A l'urétroscopie, on trouva à cet endroit des vaisseaux variqueux qui étaient coagulés. L'auteur relate les cas similaires antérieurement décrits dans la littérature et fait ressortir, que de telles altérations ne paraissent pas avoir été roentgenologiquement démontrées jusqu'à présent.

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AUS DEM KRANKENHAUS DES FINNISCHEN ROTEN KREUZES, VORSTAND: PROF. DR. S. A. BROFELDT RÖNTGENABTEILUNG, LEITER: DR. MED. S. MUSTAKALLIO

ÜBER DIE RÖNTGENBEHANDLUNG DER PERIARTHRITIS HUMEROSCAPULARIS[1]

von

S. Mustakallio

Die *Bezeichnung Periarthritis* gibt an sich noch nichts anderes an, als dass es sich um eine entzündliche Erkrankung der nächsten Umgebung eines Gelenkes handelt. Aus diesem Grunde wird dieser Ausdruck wohl oder übel zu einem *Gruppennamen*. Er schliesst mehrere Krankheitszustände der Gewebe ein, was zunächst von dem anatomischen Bau der Schultergegend herrührt. Vor allem darauf dürfte es beruhen, dass von dieser Krankheit im Schrifttum sehr verschiedene Namen gebraucht wreden. So begegnet man in der Literatur Bezeichnungen wie Bursitis subdeltoidea, Bursitis subacromialis, Tendinitis, Peritendinitis, Fibrocitis, Myocitis u. a. und ferner von den vier erstgenannten Formen Namen mit dem Attribut calcarea. In meinem Material sondere ich sie nicht als Gruppen führ sich aus, sondern stelle sie zu den allgemeinen Periarthritiden, weil wir es auch bei ihnen gewöhnlich mit einer ausgedehnteren Periarthritis zu tun haben.

Die Articulatio acromioclavicularis ist häufig bei einer Periarthritis humeroscapularis affiziert. Die Arthritis des genannten Gelenkes ruft oftmals ein ähnliches Krankheitsbild hervor wie die Periarthritis. Sie verursacht jedoch nicht so leicht wie diese eine Einschränkung der Bewegungen im Schultergelenk und äussert sich in Form einer scharf umschriebenen Empfindlichkeit bei diesem Gelenk. Die Arthritis deformans ist in diesem Gelenk recht gewöhnlich und zeigt die auf den Röntgenbildern sichtbaren Veränderungen (LINDBLOM 1935). In manchen Fällen sind jedoch auf den Röntgenbildern keinerlei Alterationen zu finden. In der folgenden Darstellung berücksichtige ich diese Arthritis in meinem Material als getrennte Gruppe, weil sie sich meines Erachtens so eng an das Krankheitsbild der Periarthritis humeroscapularis anschliesst und oft nur einen Teil dieser Krankheit bildet.

Bei der Red. am 14. I. 1939 eingegangen.

Eine besondere Gruppe bilden unter den Periarthritiden *die traumatischen Periarthritiden.* Augenscheinlich handelt es sich allerdings auch hier um eine Affektion, die den ohne Trauma entstehenden Periarthritiden sehr nahekommt. Nach SEIFERT (1930) würde diese so entstehen, dass schon durch ein kleines Trauma ein Hämatom unter dem M. deltoideus oder eine Kapselruptur verursacht werden kann. Die Organisation des Hämatoms oder die traumatische Entzündung führt zu Verwachsungen der Gleitflächen der adduzierten und unbeweglich gehaltenen Schulter. Zu ähnlichen Verwachsungen und zu einer Einschränkung der Motilität führt auch die ohne Trauma entstehende Periarthritis. Nach BÖHLER (1937) wird bei dem Trauma meistens das Caput longum des im Sulcus intertubercularis verlaufenden Musculus biceps geschädigt, wobei es zu Verwachsungen mit der Umgebung sowie zu einem entzündlichen Prozess und Empfindlichkeit in der Umgebung der Sehne kommt. Die Stelle des Sulcus bicipitalis ist denn auch in diesen Fällen meist stark empfindlich. Dasselbe gilt auch oft von der Stelle der Spitze des Processus coracoideus. Nach einer unmittelbaren Kontusion tritt die Empfindlichkeit naturgemäss an der Stelle auf, die von der Gewalt betroffen worden ist.

Im allgemeinen wird bei den Periarthritiden der *bei den Insertionen der Muskeln bestehenden begrenzten Empfindlichkeit* fast gar keine Beachtung geschenkt. Doch scheint es, als handele es sich in manchen Fällen gerade um einen begrenzten Insertionsschmerz. Wird in die Insertionsstelle z. B. Novokainlösung eingespritzt, so verschwinden die Schmerzen und die Empfindlichkeit aus dem ganzen Gelenk. Solche begrenzte Schmerzpunkte findet man am gewöhnlichsten in der Spitze des Processus coracoideus und des Tuberculum majus. Ebenso kann man Empfindlichkeit und Schmerzen beobachten, die sich ausschliesslich auf die Insertion des Musculus deltoideus auf der lateralen Oberfläche des Humerus beschränken. Auch auf den Röntgenbildern sind dann mitunter periostale Veränderungen festzustellen. In diesem Zusammenhang will ich jedoch nicht näher auf sie eingehen.

In Fällen von Periarthritis humeroscapularis sind sehr verschiedenartige *Behandlungsmethoden* empfohlen worden. Allgemein ist nachgerade bekannt, dass *die Fixierung des Oberarmes in Adduktion ein verhängnisvolles Verfahren ist.* Denn an den periartikulären Gleitflächen entstehen leicht Verwachsungen. Ausserdem schrumpfen die Adduktoren leicht in dieser Stellung, und die Abduktoren, die überdehnt sind, verkümmern. So wird die Schulter in kurzer Zeit steif, und danach ist es schwer und auch schmerzhaft, die Bewegungen im Schultergelenk frei zu machen.

Ausgezeichnete Resultatet hat man in der Behandlung der Periarthritis humeroscapularis mit *Röntgentherapie* erzielt. Schon 1926 konnte der Schwede RENCK in acht Fällen gute Ergebnisse melden. In

diesen Fällen dauerte die Behandlung gewöhnlich 3—6 Wochen. Die Patienten bekamen als Röntgentherapie alle 14 Tage $^1/_3$ HED, je nach Bedarf wiederholt.

In der Literatur wird die Behandlung der uns interessierenden Krankheit im allgemeinen einseitig behandelt. Es liegt jedoch auf der Hand, dass man in schweren Fällen mit kombinierten Behandlungsmethoden zu den besten Ergebnisse kommt. Wie aus meinen später mitgeteilten Tabellen ersichtlich wird, erzielt man auch mit blosser Röntgentherapie in sehr vielen Fällen eine vollständige Heilung ohne andere Behandlung, aber in schweren Fällen sind auch andere Verfahren und Röntgentherapie nur als ein Hilfsmittel zur Anwendung gekommen.

Mein *Material* stammt von der Röntgenabteilung am Krankenhaus des Finnischen Roten Kreuzes. Im ganzen sind auf der Abteilung etwa 200 Fälle von Periarthritis humeroscapularis behandelt worden. Bei der nachträglichen Erkundigung konnten jedoch bei weitem nicht alle Patienten angetroffen werden. Aus diesem Grunde enthält mein eigentliches in den Tabellen auftretendes Material nur 113 Fälle. Von diesen sind nur 17 in dem Krankenhaus und 96 poliklinisch behandelt worden. Humeroskapulararthritiden habe ich überhaupt nicht aufgenommen. Mein Material ist in folgende vier Gruppen eingeteilt:

Periarthritis humeroscapularis acuta	15 Fälle	
Periarthritis humeroscapularis chronica	52 »	
Periarthritis humeroscapularis traumatica	35 »	und
Arthritis acromioclavicularis	11 »	
Zusammen	113 Fälle	

Unter akuten Fällen habe ich hier nur solche verstanden, bei denen die Schulterschmerzen nicht über drei Wochen gedauert haben. Die Neuralgien, Neuritiden und Polyarthritiden habe ich aus meinem Material zu eliminieren versucht.

Die *Röntgenuntersuchung* hat in zahlreichen Periarthritisfällen ein positivies Resultat gegeben. Einen genauen Hundertsatz kann ich nicht anführen, weil nicht in allen Fällen ein Röntgenbild aufgenommen worden ist. Im grössten Teil der Fälle war jedoch bei der Röntgenuntersuchung nichts auf einen pathologishen Zustand hinweisendes festzustellen. In den meisten positiven Fällen handelt es sich um die sog. *Periarthritis calcificans s. calcarea.* (Abb. 1 u. 2.) Wie ich schon früher erwähnte, habe ich diese Fälle nicht als eine besondere Krankheit abgetrennt, sondern sie sind zu den Periarthritiden gerechnet worden. Ausser den Kalkkonkrementen in der Umgebung des Gelenkes findet man in mehreren Fällen auch *Veränderungen anderer Art.* Die *gewöhnlichsten* von diesen sind *die gewissermassen auf eine beginnende deformierende Arthritis deutenden kleinen Knochenzacken oder -kämme in der Gegend des*

Abb. 1. In der Gegend des Tuberculum majus Kalkschatten.

Abb. 2. Ein platter Kalkschatten in der Nähe des Tuberculum majus, zugleich im Tuberculum majus kleinfleckige Atrophie. Ganz an der Oberfläche Kalk vermehrt und die Konturen undeutlich.

Tuberculum majus. (Abb. 3—5.) Wahrscheinlich entstehen sie im Gefolge einer Muskelinsertionsperiostitis. Ein dritter positiver Befund besteht in einem leichten fleckigen Kalkschwund vor allem in der Gegend des Tuberculum majus. In einigen Fällen erscheint als einziger positiver Befund eine Undeutlichkeit der Kontur des Tuberculum majus, die man auch vor allem auf den Entzündungsprozess bei den Muskelinsertionen zurückführen möchte.

Über die *Röntgentherapie*, die ich verwendet habe, möchte ich folgendes bemerken: Als Apparat ist der »Tiefentherapie-Coolinan» der Firma Sanitas angewandt. Alle Behandlungen sind mit der Spannung 160 kV und mit 4 mA gegeben. Als Filter wurde 0.5 mm Cu + 1 mm Al gebracuht, und der Behandlungsabstand betrug immer 30 cm. Mit diesen Werten wurde eine Intensität von etwa 30 r in der Minute erreicht. Sämtliche Dosen sind in r-Einheiten ausgedrückt und auf der Haut mit dem Hammer-Dosimeter gemessen. Mehrmals haben die Patienten vor der Röntgentherapie, Behandlung anderer Art bekommen, da dieselbe aber in diesen Fällen nicht zur Genesung geführt hat, ist keine Rücksicht darauf genommen worden. Haben die Patienten dagegen nach der Röntgentherapie anderweitige Behandlung erhalten, so ist dies in einer eigens aufgestellten Tabelle vermerkt. Es sei hier hervorgehoben, dass die Patienten oft auf eigene Initiative andere Behandlung genommen haben, wie Massage und »Wassertherapie».

Abb. 3. In der Spitze des Tuberculum majus eine kleine Knochenzacke und in den obersten Teilen des Tuberculum eine Zunahme der Kalkmasse.

Abb. 4. In der Gegend des Tuberculum majus fleckige Knochenatrophie, das Tuberculum selbst gewissermassen geschwollen, und seine Spitze weist einen Knochenkamm auf.

In den Tabellen 1 und 2 ist eine Zusammenfassung über das Material gegeben. Werfen wir einen allgemeinen Blick auf das Material, so konstatieren wir zunächst, dass *traumatische Periarthritiden* in bedeutender Menge vorliegen. Zugleich sehen wir, dass *die meisten Periathritiden erst im chronischen Stadium in Behandlung kommen.* Aus Tabelle 1 wird ersichtlich, dass *das durchschnittliche Alter der Patienten in allen Gruppen ziemlich dasselbe, nämlich etwa 50 Jahre ist.* Die Männer sind im allgemeinen etwas weniger stark vertreten als die Frauen, namentlich in der Gruppe Athritis acromioclavicularis ist diese Differenz bemerkenswert gross, aber das kann teilweise auf dem geringen Umfang des Materials beruhen. *Geistig Arbeitende finden sich in dem Material etwas mehr als körperlich Arbeitende.* Die Disposition für diese Krankheit wird also jedenfalls nicht durch die ausgiebige Anwendung des Schultergelenkes erhöht. Andererseits geht aus der Tabelle hervor, dass *die rechte*

Abb. 5. In der Articulatio acromioclavicularis eine ausgeprägte Arthritis deformans. Auf der Oberfläche des Tuberculum majus kleine Zacken.

Tabelle 1.

Diagnose	Zahl der Fälle	Alter durchschnittlich	♂	♀	Körperlich Arbeitende	Geistig Arbeitende	Rechts	Links	Begrenzte Bewegungen
Periarthritis ac.	15	47	6	9	7	8	12	3	11
» chr.	52	51½	22	30	20	32	36	17 [1]	37
» traumatica .	35	50	17	18	14	21	20	15	30
Arthr. acromioclavic. . . .	11	55	3	8	5	6	10	2 [1]	4
	113	50½	48	65	46	67	78	37	82

Schulter viel häufiger als die linke erkrankt. Ziehen wir nur die akuten und chronischen Periathritiden in Betracht, so sind von ihnen *48* von 67 *rechtseitige* (70 %). Ich gebe im folgenden im allgemeinen keine Prozentzahlen, da der geringe Umfang des Materials solche unsicher macht. Der Anschaulichkeit halber führe ich jedoch in Klammern einige Prozentzahlen an. Bei den traumatischen Periarthritiden ist der Unterschied nicht annähernd so gross, aber bei der Arthritis acromioclavicularis ist er am allergrössten. Von diesen sind nicht weniger als 10 von 12 rechtsseitige. Dasselbe Verhalten ist auch von zahlreichen anderen Forschern, wie KAHLMETER und SANDSTRÖM, festgetellt worden. Dies hat man so erklären wollen, dass die rechte Schulter leichter überanstrengt werde oder einem »chronischen Trauma» ausgesetzt sei. Die Tatsache, dass diese Affektion bei den körperlich Arbeitenden seltener als bei den geistig Arbeitenden ist, spricht gegen die Rolle eines »chronischen Traumas». Dagegen entsteht eine Überanstrengung auf der rechten Seite leichter bei den geistig als den körperlich Arbeitenden, so dass sie für diese Erscheinung von erheblicher Bedeutung sein kann. Offenbar ist dazu noch eine andere Ursache erforderlich, möglicherweise eine Herdinfektion.

Die *Bewegungen* sind am häufigsten in den traumatischen Fällen *beschränkt*, und zwar in 30 von 35 (86 %). Bei den anderen Periarthritiden ist diese Einschränkung ein wenig geringer.

In der Tabelle 2 sind die Ergebnisse der *Röntgentherapie* vorgeführt. Bei dieser wurden *kleine Dosen angewandt. In den akuten Fällen kam man gewöhnlich mit zwei Dosen von 150 r aus, die entweder an unmittelbar oder ganz dicht aufeinanderfolgenden Tagen gegeben wurden.* Nur in wenigen Fällen wurden grössere Dosen benutzt, und nur in einem Fall war mehr als eine Behandlungsserie erforderlich. In den *chronischen Fällen* wurden im allgemeinen auch *einmalige Dosen von 150 r* gegeben, aber in den meisten Fällen musste die Behandlung *in mehreren Serien*

[1] Fall doppelseitig.

Tabelle 2.

Diagnose	Zahl der Fälle	Geheilt				Rezidive	Geheilt oder verbessert				Auch anderweitige Behandl. bekommen
		Nach 1 W.	Nach 3 W.	Nach ½ J.	Nachträgl. Erkundig.		Nach 1 W.	Nach 3 W.	Nach ½ J.	Nachträgl. Erkundig.	
Periarthritis ac. . . .	15	6	11	12	15	1	15	13	14	15	4
» chr. . . .	52	7	24	34	39	7	49	48	47	49	20
» traumatica	35	3	8	21	21	1	32	34	35	35	20
Arthr. acromioclav. . .	11	1	1	4	5	0	9	9	10	11	5
	113	17	44	71	80	9	105	104	106	110	49

fortgesetzt werden, gewöhnlich mit Intervallen von einigen Wochen oder Monaten. *Bei den traumatischen Arthritiden und den Akromioklavikulararthritiden ist ungefähr dieselbe Behandlungsmethode zur Anwendung gekommen.*

Der *Wert der Röntgentherapie* bei den Periarthritiden ist sehr schwer bündig nachzuweisen, denn man kann immer behaupten, dass der Patient möglicherweise ebenso schnell auch ohne Röntgentherapie oder bei einer anderen Behandlung geheilt worden wäre. Hiergegen kann allerdings eingewendet werden, dass die meisten chronischen Fälle vor der Röntgentherapie oft recht verschiedenartige physikalische und medikamentöse Behandlung ohne Erfolg erhalten haben.

Bei der *Beurteilung der Resultate* sind notgedrungen auch die eigenen Angaben der Patienten in Betracht zu ziehen. Mit grosser Sicherheit darf jedoch meines Erachtens gesagt werden, dass die Heilung der Röntgentherapie als Verdienst angerechnet werden muss, wenn die Schmerzen einige Tage nach der Röntgentherapie verschwunden sind, nachdem sie vielleicht sogar Jahre lang bestanden haben. Gewöhnlich nehmen die Schmerzen schon gleich nach der ersten Behandlung ab. Einige Patienten teilen mit, dass sich die Schmerzen schon während der Behandlung linderten. In einem Fall z. B. verschwanden die Schmerzen knapp eine halbe Stunde nach der Behandlung und traten danach nicht wieder auf. Eine Zunahme der Schmerzen in den Tagen nach der Röntgentherapie, wie man sie oft bei der Anwendung grösserer Dosen beobachtet, kam in diesen Fällen nicht vor. Die schnelle Heilung des Patienten nach der Röntgentherapie kann keiner anderen Behandlung zugeschrieben werden, denn z. B. in den akuten Fällen haben nur 4 Patienten nach der Röntgentherapie anderweitige Behandlung bekommen. 11 Patienten sind ohne irgendwelche andere Therapie geheilt worden. Auch in den chronischen Fällen haben nur 20 von 52 Patienten Behandlung anderer Art erhalten.

Vergleichen wir dann die in den verschiedenen Gruppen durch Röntgentherapie erzielten Resultate miteinander, so finden wir, dass bei den *akuten Periarthritiden* am meisten Fälle *im Lauf einer Woche gesund geworden sind*. In den anderen Gruppen ist das Ergebnis nicht so gut. Drei Wochen nach der ersten Behandlung ist die Zahl der Geheilten in allen Gruppen verdoppelt, ausser bei der Arthritis acromioclavicularis, wo sie unverändert geblieben ist. In der *akuten Gruppe werden innerhalb 3 Wochen 11 von 15* und in der *chronischen Gruppe 24 von 52* geheilt. Bei den traumatischen Periarthritiden ist das Ergebnis wesentlich schlechter. Nach einem halben Jahr hat sich die Situation in allen Gruppen noch erheblich verbessert. Namentlich in den zwei letzten Gruppen ist die Verbesserung am allerbedeutendsten. Zur Zeit der nachträglichen Erkundigung sind alle akuten Periathritiden geheilt. Bei der *Arthritis acromioclavicularis* war das Resultat am schlechtesten, was augenscheinlich darauf beruht, dass es sich in einem grossen Teil der Fälle um Arthritis deformans handelt.

Rechnen wir auch die Fälle mit, die sich durch Röntgentherapie beträchtlich gebessert haben, so kommen wir zu noch günstigeren Heilungsergebnissen. *In der akuten Gruppe finden wir innerhalb einer Woche alle Fälle gesund oder gebessert.* Zur Zeit der nachträglichen Erkundigung befinden sich fast alle Patienten besser als zu Beginn der Behandlung.

Die *Gruppe der traumatischen Periarthritiden* verdient eine etwas eingehendere Betrachtung. Von grossem Interesse ist es zunächst, das Alter der Patienten durchzumustern. Das *durchschnittliche Alter* ist *bemerkenswert hoch*, nämlich 50 Jahre. Auf die verschiedenen Altersgruppen verteilen sich die Fälle wie folgt:

0—22	Jahre	0 Fälle
23—29	»	2 »
30—39	»	5 »
40—49	»	4 »
50—59	»	12 »
60—69	»	10 »
70—79	»	2 »
		35 Fälle

Aus diesen Zahlen ist also zu ersehen, dass 24 der Patienten über 50 Jahre alt waren. *Bei den von traumatischer Periarthritis befallenen Patienten ist das durchschnittliche Alter dasselbe wie bei den Patienten, die an Periarthritis ohne Trauma erkrankt sind.* Hieraus können wir den Schluss ziehen, dass die Disposition des Patienten für Periarthritis bei hohem Alter einen wichtigen Faktor darstellt und dass das Trauma nur eine provozierende Ursache gebildet hat. Was die Art des Traumas betrifft, richtet sich das Augenmerk besonders darauf, dass die Periarthritis bei ungefähr der Hälfte der Patienten durch einen Sturz ausgelöst worden

ist. Um direkte Gewalt hat es sich nur in vier Fällen gehandelt. Die Anamnese hat durchschnittlich $2^1/_2$ Monate umfasst, abgesehen von einem Patienten, dessen Trauma ganze 3 Jahre vor dem Beginn der Behandlung zurückliegt. *Die Bewegungen waren zur Zeit der Einleitung der Therapie nur bei einem Patienten frei.*

Das unmittelbare Heilungsresultat ist bei den traumatischen Periarthritiden bedeutend niedriger als bei den anderen eigentlichen Periarthritiden nur 3 sind nach Verlauf einer Woche gesund, nach drei Wochen ist die Zahl der Genesenen jedoch schon 8 und nach einem halben Jahr 21 von 35. Diese Zahl steigt dann auch bei der nachträglichen Erkundigung nicht mehr an, was sich zunächst daraus erklärt, dass ziemlich viele Patienten ein verhältnismässig schweres Trauma gehabt haben; infolge dessen bleiben die Bewegungen leicht einigermassen beschränkt, obgleich die Schmerzen verschwinden. Dies wird auch daraus ersichtlich, dass 21 Patienten nach einem halben Jahr ganz gesund sind und die übrigen 11 nur mitunter Schmerzen und ein Gefühl der Steifigkeit in der Schulter haben. Nur bei zwei Patienten ist der Zustand fortgesetzt schlecht. *Auch bei den traumatischen Arthritiden scheint dieselbe Röntgentechnik gut am Platz zu sein wie bei den ohne Trauma entstehenden Periarthritiden*, was auch natürlich ist, da die Krankheit selbst offenbar die gleiche ist.

Will man die Prognose der Periarthritiden beurteilen, so ist es ausserordentlich wichtig zu wissen, *wie oft diejenigen Periarthritiden rezidivieren*, die zwischendurch geheilt sind. Um dies zu veranschaulichen, habe ich in Tabelle 2 eine besondere Kolumne gebildet, aus der hervorgeht, *in welchem Masse diejenigen Fälle von neuem erkranken, die innerhalb eines halben Jahres nach der ersten Behandlung genesen sind.* Die Zahl der Rückfälle ist überraschend niedrig. *Bei der Arthritis acromioclavicularis* sind überhaupt *keine Rezidive vorgekommen und bei den traumatischen Periarthritiden unter 21 nur 1.* Fast ebenso gering ist die Relapsfrequenz bei den akuten Periarthritiden. *Bei den chronischen Periarthritiden haben unter 34 Fällen 7 Rezidive stattgefunden.* In den meisten Fällen war das Rezidiv sehr leicht. Hierzu könnte man bemerken, dass die Beobachtungszeit der Patienten zu kurz gewesen sei, aber es scheint sich doch so zu verhalten, denn die durchschnittliche Beobachtungszeit hat $2^1/_2$ Jahre gedauert, und z. B. in den akuten Fällen wurden 5 Patienten über 5 Jahre verfolgt, ohne dass bei ihnen ein einziges Rezidiv aufgetreten wäre. In den chronischen Fällen scheint die Menge der Rezidive desgleichen im Lauf der Zeit nicht nennenswert zuzunehmen. *Die meisten Rezidive finden nämlich bereits während des ersten Jahres statt.*

Bei der Beurteilung der verschiedenen Behandlungsmethoden, die bei der Periarthritis humeroscapularis angewandt werden, ist unbedingt zuzugeben, dass die Röntgentherapie bei dieser Krankheit ausserordentlich gute Resultate zeitigt, wie aus dem von mir vorgeführten Material

ersichtlich wird. Doch will ich durchaus nicht leugnen, dass vor allem aktive Bewegungstherapie in schweren Fällen bei der fortgesetzten Behandlung dieser Krankheit von grosser Bedeutung ist. In einigen Fällen ist während der ersten Phasen der Behandlung die Anlegung einer Abduktionschiene ohne Zweifel sehr wichtig, aber von Immobilisation in Adduktionsstellung muss gänzlich abgesehen werden.

Die Behandlung der Periarthritis wäre in den meisten Fällen geeigneterweise mit Röntgentherapie einzuleiten. Es erhebt sich dabei die Frage, welche Art von Röntgentherapie gegeben werden sollte. Beim Vergleich über die Behandlung angeführten therapeutischen Ergebnisse und der Röntgendosen bemerkt man, dass, wenn der Patient nicht mittels einer kleinen Röntgendosis geheilt wird, auch eine grössere Dosis kaum Hilfe bringt. *In den meisten Fällen ist es am besten, die Röntgentherapie so zu beginnen, dass zuerst von vorn 150 r und am folgenden Tage* oder mit Intervallen von ein paar Tagen *dieselbe Dosis von rückwärts gegeben wird.* In manchen Fällen genügt dies schon für die Heilung der Krankheit. Dauern die Schmerzen aber fort, so muss die Behandlung nach einer oder ein paar Wochen wiederholt werden. Wenn auf den Röntgenbildern auf eine Arthritis deformans deutende Veränderungen hervortreten, ist es offenbar von Nutzen, etwas grössere Dosen oder diese Dosis von 150 r mehrere Male zu geben. *Im Zusammenhang mit den Röntgenbehandlungen müssen die Patienten stets aufgefordert werden, in der Zwischenzeit den Oberarm aktiv zu bewegen.* Sind die Bewegungen stark beschränkt und werden sie nicht bald nach den Röntgenbehandlungen ganz frei, so ist unverzüglich zu der anderweitige Behandlung entsprechend der Art des Falles zu greifen. Dies gelingt dann auch oft schon besser, denn nach der Röntgentherapie verschwinden die Schmerzen gewöhnlich oder bessern sich zum mindesten in dem Grade, dass die Bewegungen in der Schulter dem Patienten keine grossen Schmerzen verursachen.

ZUSAMMENFASSUNG

Im ganzen sind etwa 200 Fälle behandelt worden. Bei der Nachträglichen Erkundigung konnten nur 113 Fälle angetroffen werden. Die Fälle wurden durchschnittlich $2^1/_2$ Jahren verfolgt. Das Material ist in folgende Gruppen eingeteilt: akute, chronische und traumatische Periarthritiden und Arthritiden des Akromioklavikulargelenks. In den akuten Fällen kam man gewöhnlich mit zwei Dosen von 150 r aus, in den anderen Gruppen wurde etwas mehr Behandlung gegeben. Von den akuten Periarthritiden wurden während der ersten Woche 6 von 15 geheilt, in den anderen Gruppen ist das Resultat wesentlich schlechter. Nach drei Wochen wurden von den akuten Periarthritiden 11 von 15, von den chronischen 24 von 52, von den traumatischen 8 von 35 und von Arthritis acromioclavicularis nur 1 von 11 geheilt. Nach einem halben Jahr genasen von allen Gruppen zusammen 71 von 113 (63 %). Zu der Zeit der nachträglichen Erkundigung beläuft sich die Zahl der Geheilten oder Gebesserten in allen anderen Gruppen auf 100 %, nur in der chronischen Gruppe 49 von 52 (94 %).

SUMMARY

In all about 200 cases have been treated. Only 113 cases were found during the subsequent inquiries. The cases were under observation for $2^1/_2$ years on an average. The material is subdivided in the following four groups: acute, chronic and traumatic types of periarthritis and arthritis of the acromioclavicular joint. Two doses of 150 r were generally sufficient in the acute cases. Somewhat more treatment was required in the other groups. 6 out of 15 patients with acute periarthritis were cured during the first week. The result was fairly much worse in the other groups. 11 out of 15 patients with acute periarthritis recovered after 3 weeks, this was the case also with 24 out of 52 patients with chronic periarthritis, with 8 out of 35 with traumatic periathritis and with only one out of eleven with arthritis acromioclavicularis. 71 out of 113 (63 %) patients from all the groups recovered after half a year. At the time of the subsequent inquiries 100 per cent of the patients from all the other groups had recovered or grown better, this being the case with 49 out of 52 (94 %) patients in that group only which comprised chronic cases.

RÉSUMÉ

En tout on a traité à ce Service 200 cas. A l'enquête faite plus tard on n'a pu retrouver que 113 cas. En moyenne, on a suivi ces cas pendant deux ans et demi. Une classification des cas a éte faite dans les quatre groupes suivants: la périarthrite aiguë, chronique et traumatique et l'arthrite acromio-claviculaire. Deux doses de 150 r sont en règle générale suffisantes dans les cas aigus. Dans les autres groupes le traitement a été un peu plus fort. Quant aux cas de périarthrite aiguë 6 cas sur 15 ont guéri au cours de la première semaine. Dans les autres groupes le résultat est beaucoup plus mauvais. Après trois semaines 11 sur 15 des cas de périarthrite aiguë sont guéris, 24 sur 52 des cas chroniques, 8 sur 35 des cas traumatiques et un cas seulement sur 11 des cas d'arthrite acromioclaviculaire. Au bout de six mois un total de 71 cas (63 %) sur 113 de tous les groupes ensemble sont guéris. A l'époque de l'enquête ultérieure, le nombre des guéris ou ceux ou une amélioration est entrée, s'élève pour tous les autres groupes à 100 %, tandis que le groupe des cas chroniques présente un chiffre de 49 guéris sur 52 (94 %).

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STEREOSCOPIC MEASUREMENT OF DISTANCES IN THE FEMALE PELVIS AND ON THE FOETAL SKULL[1]

by

Benedict Westergaard

Since the discovery of roentgen rays in 1895, numerous attempts have been made to make precise radiological measurements of diameters on the foetal skull and in the female pelvis.

Broadly speaking, these attempts have been made either on the basis of a single exposure of the object, or on that of a combination of two exposures.

There are two methods of using a single exposure. In the first, a graduated ruler is placed in the same plane as the diameter to be measured, so that its shadow on the film will be distorted by the same amount as the shadow of this diameter. The second method consists of placing the patient so that the plane of the diameter is parallel to the film, in order that the distance as recorded on the film may be used for calculating the actual distance geometrically.

By the double exposure method, the diameter to be ascertained has been determined 1. by means of geometrical construction 2. by reconstructing the course of the rays in space with the aid of threads, and, 3. by stereoscopic exposure and vision.

In the following a description is given of some attempts at stereoscopic measuring of the diameters referred to, which, at the suggestion of Prof. ERIK RYDBERG, were undertaken by Drs. OVE WISSING and B. WESTERGAARD in the roentgen department of the S. Lukas Hospital in Copenhagen.

The stereoscopic method was chosen because it has several important advantages over the others.

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In the single exposure method two principal difficulties arise.

In the first place, it is necessary, in order to obtain an exact measurement, to know the situation and the direction of the diameter to be ascertained. If we use the system of geometrical calculation this knowledge is necessary in order to place the patient in such a manner that the direction of the diameter is parallel to the film. If we use the system of the filmed-in ruler, the same knowledge is necessary in order to place the ruler in the plane of the diameter. It has been found absolutely impossible, however, to find fixed points on the exterior of the pelvis, by which the direction of the interior diameters might be determined. The same applies also to the foetal skull. It is therefore impossible to be certain that, in the position in which the patient is eventually placed for radiography, the direction of the diameter to be measured is actually parallel to the film, or, if the graduated ruler is employed, that the latter lies in the exact plane of that diameter. This difficulty is entirely avoided by using the stereoscopic method, which, in contrast to the methods based on a single exposure, does not require that the situation and direction of the diameter shall be known beforehand, but only that the bony points between which the measurements are to be taken shall be visible in the picture, that is, that they lie sufficiently clear of the other bony shadows.

In the second place, in roentgen pictures which are not viewed stereoscopically, it will often be very difficult to localise with certainty the right bony points. This difficulty is considerably lessened by stereoscopic vision.

With the double exposure method there is the same difficulty of localising the proper bony points in all cases where stereoscopic vision is not employed. Furthermore, the uncertainty of the geometrical constructions and the inexactness in any reconstruction of the direction of the roentgenrays in space by means of threads make those procedures, too, inferior to the stereoscopic method.

Finally, the latter has the advantage over all the others that the observer, without any preliminary construction or calculation, obtains a plastic view — i. e. a perception of depth in space — of the object radiographed. This is of special importance in the cases where the size of the pelvic canal in relation to that of the foetal head has to be estimated.

To ensure exactness of the stereoscopic measurements, it must be determined that the geometrical course of the roentgenrays is the same during stereoscopic vision as during exposure. This will be the case if the observer takes care that during the observation each of his eyes is in the same position in relation to the film on the same side, as was the focus corresponding to it during the exposure. In other words, we must

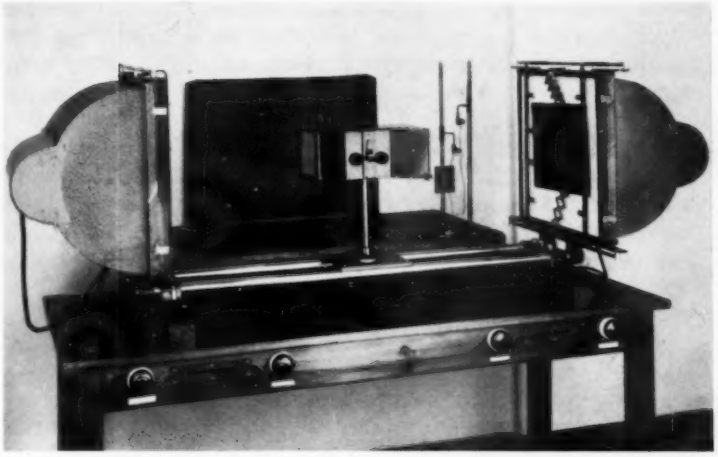

Fig. 1. Photograph of the stereoscope.

take care, that the parallax-angles are the same during observation and exposure.

The apparatus used for the experiments were, for radiography, a Rotalix roentgentube suspended from a gallows, for viewing, a stereoscope constructed on the principle indicated by WHEATSTONE.

When the stereoscope is to be used, the films are placed in two viewing-boxes, one at each end of an optic bench, in the middle of which are two semitransparent, platinum-coated mirrors set at an angle of 90° to each other, and each forming an angle of 45° with the frontal plane. The light will be reflected from the mirrors, and will reach the observer's eyes when these are placed in front of the mirrors in a plane parallel to the longitudinal axis of the bench. If the adjustment is correct, the direction of the rays between the film and the eye on the same side will be precisely the same as between the corresponding focus and the film during exposure, except for the reflection of the cones of rays by the mirrors, which need not be considered, however, as it does not alter the angles which the different rays of the beam form with one another.

The result of this arrangement will be, that the observer will see in the space behind the mirrors, a virtual image, with depth in space, of the object to be investigated. The points, between which it is desired to measure the distance, can be marked in this image by means of small, luminous marks, — for instance by means of a small electric bulb covered with a cap in which an angular incision has been made, and which can be

moved in all directions, — and the distance between the marks taken with calipers.

The technical details necessary for maintaining the above mentioned conditions of stereoscopic precision in exposing and in viewing the films are not described here.

During the exposure of the films the patient was placed in one of two positions, according to the nature of the information desired concerning the pelvis and the foetal skull.

For the first or frontal view the patient is placed in a kind of dentists chair with supports for the arms and feet. The patient sits on the film carrier and the tube is aimed downwards through the mid point of the pelvic inlet. The tube-shift is in the transverse plane.

The second is a lateral exposure. The central ray is directed from the lateral side and from above, into the pelvic canal. The patient is placed on her right side, with the upper part of the body elevated. It is shown to be very important that the symphysis is projected free of the shadows of the head, neck and shaft of both femurs. This is achieved by placing the patient with the upper margin of her symphysis a couple af centimeters distal to the central ray from the distal focus, in combination with her thighs lying extended maximally backwards and her pelvis turned slightly backwards.

With a target-film distance of 70 cm., the average exposing times for lateral views of non-pregnant subjects are 0.8—1.4 seconds, for lateral views of pregnant subjects 1.5—2.5 seconds, and for frontal views of pregnant subjects, 2—2.5 seconds.

It is possible to reduce the total time for the double exposure to less than 30 seconds.

What information, then, can we obtain by employing this technique?

In the first place, we get a general view of the pelvis, and of the head of the foetus, if present. The observer sees a virtual image — enlarged or diminished, or — very seldom — of the same size as the object, with depth in space, but without any distortion. This enables him to form an idea of the general shape of the pelvis and head, and in many cases to judge, without taking measurements, the size and shape of the pelvic canal and the foetal head in relation to each other.

The profile image makes measurement of the conjugata vera possible, i. e. the shortest sagittal diameter of the pelvic inlet.

The frontal image will in many cases make it possible to determine a minimum value for the conjugata vera, which may be identical with — or eventually smaller than — the true value, but at any rate never higher, and which will therefore be important in the cases where it shows normal value, or a value above normal. Further, it will be possible to

etermine from the frontal image the transverse diameter of the pelvic let and the distance between the ischial spines.

The biparietal and bitemporal diameters of the foetal head can only e determined in those cases where they lie at right angles to the central ys from the two foci. If the head has been lying rotated, it will be im- ossible to localize the proper bony points in the virtual image.

Experience shows that the tolerance af the human brain in regard to ulty adjustment of the films observed is rather great. The eyes have a ndency to see the virtual image stereoscopically. The brain will only unable to fuse the two images into one if the error of adjustment is irly considerable. Therefore it is not possible from the virtual image perceive immediately whether an exact geometrical correspondence ists between the conditions of exposing the films and of viewing the diographs.

The errors liable to affect the results of our measurements may be vided into the following principal groups:

1) Errors due to a faulty geometrical correspondance between the conditions (i. e. course of roentgenrays) of exposing the films and viewing the radiographs — in other words, to an alteration of the parallax angles.

2) Errors of calculation due to wrong determination of the target-shift distance (basis of exposure) and of the pupillary-distance of the observer (basis of observation).

3) Errors due to movements of the patient during and between exposures, and, finally.

4) subjective errors in measuring, depending on the greater or lesser stereoscopic faculty and practice of the investigator.

It is well known that it is far more difficult to determine the position in space of a given point in an object than its position in a frontal plane. The same is the case, in still greater degree, with regard to points in the virtual roentgen image, and if, furthermore, there is a faulty geometrical correspondence between the conditions of exposing the films and viewing the radiographs the uncertainty of the depth determination will be considerably increased. This error will be greater the farther the distance to be measured extends in depth. We therefore try as far as possible to obtain a frontal adjustment.

To determine whether the method is of use, it is necessary to make check measurements on objects of known size. We have done so on radiographs (1) of a metal-edged wooden cube cut into two equal halves, (2) of the skeletons of a pelvis and of a mature foetal skull, (3) on profile radiographs of a series of cases from the maternity department and gynecological service of the Rigshospital, Copenhagen, in which actual measurements of the conjugata vera had been done, during laparotomy, by means of calipers specially constructed for the purpose.

Measurement of the conjugata vera has been chosen as a control for the whole method for three reasons. Firstly, because it is the most difficult diameter in the pelvis to determine. Secondly, because in most cases it is the pelvic diameter which has the greatest obstetrical interest. Thirdly because it is the only pelvic diameter which can be determined with any certainty during laparotomy.

The check-measurements of the wooden cube and of the skeletons of the pelvis and foetal skull, showed errors of less than 1 millimeter for distances in frontal extension.

The check-measurements on the 21 patients will be seen from the following table.

No.	Conjugata vera		Difference	No.	Conjugata vera		Difference
	direct measurement	roentgenologic measurement			direct measurement	roentgenologic measurement	
	mm.	mm.	mm.		mm.	mm.	mm.
1 . . .	114	115.7	+ 1.7	11 . . .	110	112	+ 2
2 . . .	122—123	122.2	+ 0.2 — − 0.8	12 . . .	91—91.5	92.7	+ 1.7
				13 . . .	106—106.5	109.4	+ 3.4
3 . . .	78—79	79.2	+ 1.2	14 . . .	109.5—110	112.3	+ 2.8
4 . . .	118	119.5—119.6	+ 1.5	15 . . .	110	112	+ 2
5 . . .	122—123	125.3	+ 3.3	16 . . .	110	109.7	− 0.3
6 . . .	119	121.2	+ 2.2	17 . . .	124	127.3	+ 3.3
7 . . .	113.5—114	116.6	+ 3.1	18 . . .	127	130.4	+ 3.4
8 . . .	100	100.7	+ 0.7	19 . . .	112	112.3	+ 0.3
9 . . .	126—126.5	128.7	+ 2.7	20 . . .	110	112.8	+ 2.8
10 . . .	115	117.9	+ 2.9	21 . . .	81	81.2	+ 0.2

In nearly all the cases, the measurements obtained roentgenologically show slightly higher values than those ascertained during laparotomy. The maximum deviation is 3.4 mm. The explanation of this difference is undoubtedly to be found when the thickness of the soft tissues on the promontory and on the posterior aspect of the symphysis is taken into consideration, and as this must be estimated to about 2—3 mm., the deviation of the roentgenological values from the actual values ascertained during laparotomy is very slight.

Thus to a certain extent the errors can be eliminated, an the results obtained may consequently become of practical value.

The stereoscopic method has, in these experiments, given satisfactory results in regard to the diameter which is most difficult to determine namely, that of the conjugata vera, and moreover as already stated, this method has the advantage that it enables the investigator to get a genera plastic view of the pelvis and the foetal head.

SUMMARY

The author relates some experiments with stereoscopic measuring of diameters in he female pelvis and on the fœtal head.

For radiography, a Rotalix-roentgen-tube and for stereoscopic vision a stereoscope onstructed on the principle indicated by WHEATSTONE, were used. In frontal radiographs t is possible to determine the superior transverse diameter, the distance between the schial spines and, in some cases, a minimum value of the conjugata vera.

From profile radiographs the conjugata vera may be determined. The biparietal and itemporal diameters of the fœtal skull can only be determined in those cases where they e at right angles to the central rays from the two foci. Checking experiments with a netal edged wooden cube cut in halves and with the skeletons of a pelvis and a fœtal ead, gave errors of less than 1 mm. Checking experiments, on 21 patients, in which the entgenological measurements of the conjugata vera were compared with direct measure-ents taken during laparotomy, gave differences in no instance exceeding 3.4 mm.

ZUSAMMENFASSUNG

Verf. beschreibt einige Versuche mit stereoskopischer Messung von Durchmessern des weiblichen Beckens und des Fötuskopfes.

Für die Radiographie kam eine Rotalix-Röntgenröhre und für stereoskopisches Sehen ein Stereoskop zur Anwendung, das nach den von Wheatstone angegebenen Prinzipien konstruiert war. Bei Frontalradiographien kann man den oberen transversalen Durchmesser, den Abstand zwischen den Spinae o. ischii und in einigen Fällen einen Minimalwert der Conjugata vera bestimmen.

Durch Profilradiographien kann die Conjugata vera bestimmt werden. Der biparietale sowie der bitemporale Durchmesser des Fötusschädels lässt sich nur in Fällen bestimmen, wo sie in rechten Winkeln zu den Zentralstrahlen von den beiden Fozi liegen. Kontrollversuche an einem mit Metallkanten versehenen Holzwürfel, der in zwei Hälften geteilt war, und am Skelett eines Beckens und eines Fötuskopfes gaben Werte, die weniger als 1 mm von dem richtigen abwichen. Kontrollversuche bei 21 Patientinnen, bei welchen die röntgenologischen Masse mit direkten Massen verglichen wurden, die während der Laparotomie genommen worden waren, gaben Unterschiede, die in keinem Fall 3.4 mm überschritten.

RÉSUMÉ

L'auteur relate quelques expériences de mesures stéréoscopiques de diamètres du pelvis féminin et de la tête fœtale.

On utilisa pour la radiographie un tube roentgen Rotalix, et, pour la vision stéréoscopique, un stéréoscope construit selon le principe indiqué par Wheatstone. Il est possible de déterminer, dans les radiogrammes frontaux, le diamètre transversal supérieur, la distance entre les épines ischiales et, dans certains cas, une valeur minimum de la conjugata vera.

Dans les radiogrammes de profil, on peut déterminer la conjugata vera. Les diamètres bi-pariétal et bi-temporal du crâne fœtal ne peuvent être déterminés que dans les cas où ils sont situés à angle droit par rapport aux rayons centraux des deux foyers. Des épreuves contradictoires, effectuées avec un cube de bois muni de bords en métal et coupé en moitiés, ainsi qu'avec le squelette d'un pelvis et d'une tête de fœtus, donnèrent des erreurs de moins de 1 mm. Des épreuves contradictoires effectués sur 21 sujets, chez lesquels les mesures roentgenologiques de la conjugata vera furent comparées avec les mesures directes faites pendant une laparotomie, donnèrent des différences n'excédant en aucun cas 3,4 mm.

FROM THE RADIOLOGICAL CLINIC, LUND. CHIEF: PROFESSOR LARS EDLING, M. D.

RADIOLOGICAL TREATMENT OF SKELETAL METASTASES IN MAMMARY CANCER[1]

by

Helge B. Wulff, M. D.

The treatment of skeletal metastases in cancer of the breast was formerly and is still in many quarters aimed solely at alleviating the pain and this in the form of applications of morphine or morphine derivatives. In recent years however — with the increased frequency of radiologically (pre-operative and postoperative) treated cases of mammary cancer — a number of cases of skeletal metastases from cancer have come to radiological treatment in several countries, remarkable results having been obtained in certain cases with no slight palliative improvement.

Radiological treatment of skeletal metastases in mammary cancer is, however, of long standing, for in a work published in 1919 PFAHLER mentions that as far back as 1913 he had successfully treated a couple of cases of skeletal metastases from cancer of the breast (in the ribs and vertebral column). He was even able to record such a case with a considerable improvement for a period of five years after the roentgen treatment. Since then casuistic reports have now and again appeared in the literature showing the results obtained in cases of skeletal metastases in cancer of the breast treated with irradiation. Such cases have been published by ARCELIN, LEVIN, JENKINSON, GINSBURG, WEISSWANGE and others, while recently (1936) CLARKSON and BARKER were able to report two cases in which the patients were symptom-free for 4 and 5 years respectively after radiological treatment of such skeletal metastases and where the osseous changes seemed roentgenographically to have disappeared. In the more extensive works on radiotherapy published in 1937 and 1938 by SCHINZ and ZUPPINGER of Zürich (1937)

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and HOLFELDER of Frankfurt (1938) some results are also given of radiation therapy in such cases of skeletal metastases. SCHINZ and ZUPPINGER give an account of a relatively large number of cases of this category, while HOLFELDER (WEISSWANGE) reports rather good palliative results in two cases described more in detail.

For natural reasons it is only in exceptional cases that a large series of cancers of the breast with skeletal metastases have so far come to consistent roentgen treatment. Such treatment has occurred only in large special clinics interested in this kind of treatment, and in those instances — which is perhaps the most important point — in which cases of mammary cancer with metastases to the skeleton have been sent by surgeons for radiological treatment. Of the reports of fairly large series of cases of this kind we may first of all mention one published by GESCHICHTER and COPELAND in 1936, which comprised 34 followed and controlled cases (31 treated by irradiation, 2 treated with radium and 1 given both radiation and radium treatment), and another by LENZ and FREID in 1931, where the subsequent results were controlled and estimated in 31 cases. In both these reports the results obtained were rather good, in a few cases even very good with subjective improvement and also roentgenological-diagnostic evidence of at least a partial regression of the skeletal metastases. In the series of 21 cases of skeletal metastases from cancer of the breast reported by SCHINZ and ZUPPINGER (1937) the results were rather moderate, mainly with subjective improvements and a somewhat increased survival period, but no detailed description of the results is given.

For a long time past a keen interest has been taken in these metastases by EDLING at the *Radiological Clinic at Lund* and in recent years he has consistently treated such cases by irradiation. An experience of nearly 10 years of this therapy has now been acquired and the observations cover a relatively large number of patients. It may therefore be of a certain interest to give an account of these experiences and the results obtained at the Lund Clinic in this field of roentgen therapy.

Indications

The *indications* for the radiological treatment of bone metastases in cases of mammary cancer were considered to be present in all cases, even those with widely distributed skeletal metastases. Still those in which the general condition was too poor, or where grave anaemias were present were not given roentgen treatment. Nor was radiotherapy attempted in those cases exhibiting sure, pronounced pulmonary, pleural or hepatic metastases.

The occurrence of metastases to the lungs or liver were regarded as a relative contra-indication for treatment. Our own experiences as well as those of other workers (SCHINZ and ZUPPINGER, WEISSWANGE, KELLY and FRICKE, NORMAN TREVES and others) have proved that the treatment of bone metastases in cases of this kind is a thankless task and frequently of no use whatever, as these cases are prognostically very unfavourable and the patients die within a very short time. With regard to the treatment of pulmonary metastases in cancer of the breast NORMAN TREVES 1937 (Memorial Hospital) sums up the experiences of the New York Clinic thus: except in a few very uncommon cases, where the metastases occur in the hilum or grow spherically in the parenchyma, roentgen treatment of pulmonary metastases in mammary cancer is of no value.

Material

The series of cases of skeletal metastases from cancer of the breast from the Radiological Clinic at Lund, which will be reported and examined here, comprises 44 cases treated during the period of 9 years from the beginning of 1929 to the end of 1937 (the total number of cases with skeletal metastases from mammary cancer that occurred at the Radiological Clinic during this period amounts to 60). Of these 44 cases 5 are still alive, the others have died; it has been possible to follow all the 44 cases up to the time of death or to the conclusion of the after-examination on the 1st November 1938. In all cases the diagnosis of cancer is indisputable; in the operated cases — with but few exceptions — corroborated by patho-anatomical evidence, in the non-operated cases (those already in Stage III according to STEINTHAL, thus where irradiation directly to the mammary cancer itself had been the adequate treatment) the diagnosis, where it was not verified at biopsy or autopsy, was nevertheless beyond doubt. The majority of the cases, or more exactly 41 cases, originate from the years 1932—1937, only a small number of cases (3) occurring in the first years. In most of these after-examined cases radiological examinations of the involved or suspected parts of the skeleton have been made together with careful comparative examinations of the extension, appearance and possible changes of the skeletal metastases, blood tests, weight determinations, etc.

The *distribution* of the material in the different *age groups* does not differ from the usual statistics of cancer of the breast, and the majority of the cases, or 60 per cent., fall within the age group 40—60 years (if the time of the discovery of the primary tumour and the operation or subsequent radiological treatment are taken as the starting-point). (The figure given by LENZ and FREID for the same age group is 56 per cent.)

The material has a lower age-limit of 27 years and a upper limit of 78 years. In the age group 25—40 years there are only 7 cases, i.e. about 16 per cent. (LENZ and FREID have 32 per cent.; thus there is no evident deviation towards the younger age-classes in these cases of cancer of the breast with skeletal metastases.

With regard to the *extension and malignancy* of the cancer process in these 44 cases, it may be mentioned that, if STEINTHAL's classification into stages is followed, 6 cases may be classed as belonging to Stage I[1], 18 cases belonging to Stage II and 20 cases belonging to Stage III.

On the subject of the relation between the *pathological anatomy*, differentiation, and degree of malignancy of the primary mammary cancer in these cases, and the metastatic tendency of tumour forms and the varying sensitivity of the metastases to radiological therapy, the number of observations is as yet too small to permit of any definite conclusions being drawn. These questions are, however, of such vital importance from both theoretical and practical points of view, as for instance, indications for treatment and dosage in radiotherapy, that further investigations directed to the solution of these questions are both desirable and necessary.[2] Certain aspects of these problems will be discussed more in detail in another connection later on.

It may be of a certain value already here to mention briefly the form in which the cancer appeared in these cases treated at the Radiological Clinic in Lund. Complete patho-anatomical examinations were made in 26 out of the 32 primarily operated cases (in 12 cases the malignancy of the cancer process together with the occurrence of metastases indicated primarily radiotherapy). The distribution of these 26 cases among the different clinical groups is shown in the following table.

Pathological Anatomy

Scirrhous cancer	Cancer simplex or medullary cancer simplex	Adenocarcinoma	Indifferent cancer	Paget's disease
11 cases	10 cases	3 cases	1 case	1 case

[1] Although at several patho-anatomical institutes (the Pathological Institute at Lund, for instance) the examination of the axillary gland packet is carried out very thoroughly, it is nevertheless not done in the form of a complete series of sections, and it is therefore possible that occasionally an incipient cancerous infiltration in the lymph nodes may escape detection. Thus a case or two properly belonging to Group I may have by mistake been included in Group I in the above table.

[2] Such investigations are at present being carried on at the Lund Clinic.

As already mentioned, 32 of the 44 cases were primarily operated. Of these 32 cases 18 were regularly treated either pre-operatively, post-operatively or both pre-operatively and postoperatively with roentgen irradiation, in 14 cases no form of radiotherapy had been given in connection with the operation.

In the 12 cases that could not be primarily operated the patients were given roentgen or radium treatment direct to the local focus in the breast. In some cases simultaneous radiological treatment was given to the occurring skeletal metastases. All these 12 cases belonged to STEINTHAL's Stage III.

Technique

During the first years the technique of irradiation therapy in skeletal metastases from cancer of the breast varied somewhat at the Radiological Clinic at Lund. But on the whole the treatment can be said to have been fairly constant during all the years. Thus, with but one exception, the technique in all cases treated with roentgen-rays involved a simple, fractional radiological treatment of the affected areas of the skeleton, utilizing 165—170 kv., 3—6 m. A., at 40—50 cm. distance with as a rule 0.5 mm. copper filtration and 1 mm. Al or Thoraeus Sn filter. In general the size of the field was about 10 × 15 cm., sometimes 15 × 15 cm. and in certain cases less than 10 × 15 cm. The fractional dosage varied between 200 and 350 r and the total focal dosage amounted to 750—1,500 r. This treatment was carried out in one or more series to a larger or smaller number of fields, careful control being kept of the general condition, blood, weight, etc. of the patients, for the most part residing at the hospital.

In only one case was irradiation by MALLET's technique carried out, this method of treatment having been commenced at another hospital. This case was in a very advanced Stage III and no opinion can be formed of the claims of this method from this single case of treatment.

Teleradium treatment of metastases was employed in one case in this series. It related to an isolated metastatic process in the sternum and the dosage used was altogether 44,000 mg. hrs over 5 fields.

Results

Before making any attempt to analyse the results of the treatment it must be pointed out that every evaluation of the palliative results in such conditions as mammary cancer with skeletal metastases is — in spite of all efforts at objectivity — to a great extent subjective on ac-

count of both the examiner's more or less subjective interpretation and the patient's own attitude, mentality, sensitiveness, etc. Objective evidence for forming an estimation of the results is found in general only to a certain extent. But by combining subjective data and possibly existing objective findings it may be possible to obtain a good idea of the course of the disease and of the effect of the therapy.

Nearly all the cases included in the material from the Radiological Clinic at Lund have been judged by the same investigator during the entire period of treatment and during the subsequent control, and as a rule the subjective data supplied by the patients have been supplemented with serial roentgen examinations of the metastatic lesions in the skeleton and amplified by information and detailed records of the patients' general condition, blood and weight, etc.

Of the 44 cases included in the series from the period 1929—1937 (with a survival period[1] of 14.3 ± 5.3 months) 24, or *54.5 per cent of the entire material, showed no definite or discernible subjective improvement*, as far as can be gathered from the fairly detailed records, and *a thorough examination of a series of roentgenograms did not disclose any sure objective evidence of improvement* in the skeletal metastases following the roentgen treatment in the form of a diminution, increased calcareous content, sclerosis, etc. Finally, nothing could be gathered from the significant objective fact — the survival period — to indicate that the radiotherapy had had a favourable effect on the skeletal metastases. Thus *in these 24 cases the period of survival was* 6.8 ± 5.3 *months.*

In an analysis of the remaining 20 cases of the material, i.e. *45.5 per cent. of the total, a more or less evident subjective improvement* could be discerned in the patient's symptoms: in the majority of cases the patients stated that severe neuralgiform metastatic pains disappeared entirely within a few days to a week following the roentgen treatment, the general condition improved, the anaemias diminished, and in not a few cases the patients were able to resume their occupations of housekeeping, gardening, indeed in a few cases the heavy labour of earning their living.

In many cases objective evidence was obtained in the radiographs of the regressions of the metastatic foci, increased calcareous density in these lesions, and in a few cases the carcinomatous skeletal changes visible in the radiographs disappeared completely or almost completely.

Another important objective evidence of the favourable course of this metastatic group is the *survival period*. In these cases *the average period of survival was 23.4 months*, i.e. nearly 2 years. During this period

[1] Counting from the discovery and the treatment of the skeletal metastases.

following the discovery of the bone metastases[1] these cases not infrequently lived for the greater part of the time in a subjectively rather normal condition.

As already mentioned, in the unfavourable cases the average survival period was *6.8 months*, the corresponding figure for the entire material was *14.3 months*.

Among the above-mentioned 20 cases there were, however, 10, or *22.7 per cent. of the entire material*, in which the *effect of the radiotherapy* on the skeletal metastases seems to have been of a *still more evident nature*, therefore these cases will be dealt with more in detail.

In these 10 cases there was a great improvement in the patient's subjective condition. In nearly all cases the poor, weak patients improved to such an extent that they could be up and about, participate in the housework and in certain cases follow their regular occupations for several years. The following brief case histories will give an idea of the subjective improvements and their duration in these cases.

Case 1. 1932, ♀, aged 33, I. F.

History. Operated for fibro-adenoma (patho-anatomical examination) in left breast in September, 1929. In the autumn of 1932 a new nodule was discovered in left breast.

Operation September 22, 1932. *Amputatio mammae + Exaeresis axillae.*

Microscopic examination. Medullary cancer simplex with multiple metastases to the axillary lymph nodes. *Stage II.*

Treatment. Postoperative radiotherapy; 3 series.

Subsequent history. In August, 1933 (one year after the discovery of the primary tumour) severe pains in the lumbar and pelvic regions. Roentgen examination: Multiple osteoclastic cancer-metastases to the pelvis, lumbar and thoracic spine. After *roentgen treatment* of the foci (*3 series over 6 fields; about 3,000 r*) the patient's condition improved to such an extent that *in 1933 and 1934 she was practically free from discomfort and was able to manage her work completely.* The radiograms revealed how the osseous foci decreased in size and sclerosed. In February, 1935, the patient again complained of pains in the back and the thighs, and another series of roentgen treatment was given (*4,200 r over 6 fields*). The radiograms, however, showed the condition to be unchanged. After a subjective improvement the pains again increased at the end of 1935 in spite of the improved appearance of the metastases. *Death occurred* in increasing discomfort in the end of *March, 1936.*

The patient lived for 31 months, i. e. *2 years and 7 months* after the discovery and the roentgen treatment of the skeletal metastases; for a period of 2 years she was almost completely free of discomfort. (v. Figs. 7, 8, 9).

[1] The roentgenographic evidence of the bone metastases is probably obtained quite a long time after the microscopic discovery of the metastases. Metastatic pains of a typical nature may occur for months, in certain cases for 18 months (LENZ and FREID) before the metastases are diagnosed roentgenographically.

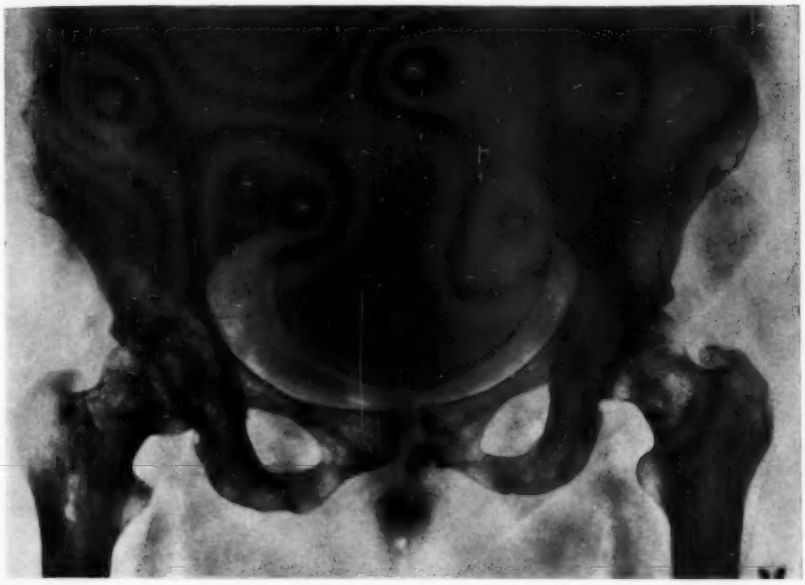

Fig. 1. M. S. Mammary cancer with skeletal metastases + pregnancy in 9th month, March 21, 1934. Multiple focal destructions in the pelvic circle and upper part of the femur. Osteoclastic phase (Stage I) before roentgen treatment.

Fig. 2. Same case as in Fig. 1, June 6, 1934. After parturition 2 series of roentgen treatments to 12 fields; about 5 800 r. Considerable sclerosis in all foci in the pelvis. Osteoblastic phase (Stage III).

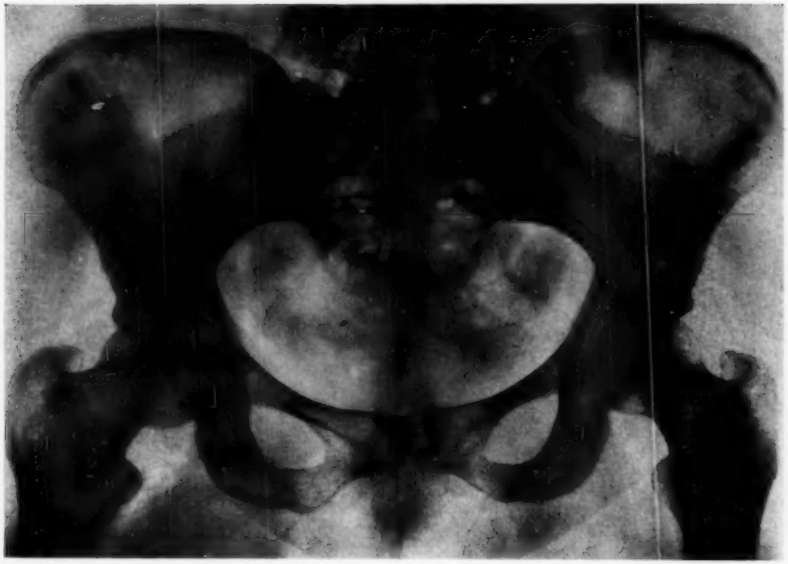

Fig. 3. Same case as in Figs. 1 and 2, January 1, 1935, about 1 year after roentgen treatment of the metastases. The majority of the foci have decreased or disappeared leaving behind sclerotic areas or areas with almost normal bone structure. Healing phase (Stages III—IV).

Case 2. 1932, ♀, aged 43, L. B.

History. For more than 2 years a growing, symptom-free node in the left breast. An examination on May 27, 1932 showed a spherical, entirely cancer infiltrated left breast fixed to the thoracic wall, the skin infiltrated and with a packet of lymph nodes, as large as an orange, in the axilla. *Stage III.*

Treatment. Intensive irradiation of the breast and the axillary glands together with intubation of radium needles in the breast itself. Small shrivelled rests of the tumours remained after the conclusion of the treatment.

Subsequent history. Since the beginning of 1933 severe metastatic pains in the spine. *Roentgen examination* revealed multiple osteoclastic metastases in the pelvis, spine and femur. *Radiological treatment* in several series was given to the foci (*2 series over 15 fields; about 6,000 r*), which resulted in a considerable subjective improvement: the patient was practically *free from discomfort during the whole of 1933.* The radiograms revealed decreased and also sclerosed foci, which in certain places, however, showed progression. *The patient was entirely free from discomfort and was quite able to work during the whole of 1934 and also 1935.* The radiograms still showed unchanged foci, in several places with a strong healing tendency. On May 5, 1936 the patient's condition had become somewhat worse, she was emaciated but still felt no pain. She was still able to work. Radiographically a certain amount of progression of the foci could be discerned. A new series of roentgen treatments (*2 fields; 1,200 r*) was given, which brought about a subjective improvement. In the spring of 1937 the patient again became worse and was confined to bed. *She died on June 11, 1937.*

Fig. 4. M. S. February 1, 1934. General calcareous atrophy along with small multiple destructions in the substantia spongiosa. Osteoclastic phase (Stage I) before roentgen treatment.

Fig. 5. Same case as in Fig. 4, August 6, 1934, after roentgen treatment (about 5 800 r to 12 fields). Considerable sclerosis in the majority of the vertebral bodies, partly appearing in large confluent areas. Osteoblastic phase (Stage III).

Fig. 6. Same case as in Figs. 4 and 5, January 23, 1935, about 1 year after roentgen treatment of the metastases. The sclerotic areas have disappeared almost entirely, leaving behind nearly normal bone structure. Healing phase (Stages III—IV)

A survival period of 50 months, i.e. *4 years and 2 months*, was recorded after the discovery and treatment of the skeletal metastases. During this period the patient was free of discomfort and *was able to continue working for 3½ years.*

Case 3. 1935, ♀, aged 62, E. B.

History. For the past 6 months a growing node in the right breast with enlarged glands in the axilla.

Operation. January 26, 1935. *Amputatio mammae* + *Exaeresis axillae* (no radical operation of the axillary glands).

Microscopic examination. Adenocarcinoma with metastases to the axillary lymph nodes. *Stage III.*

Treatment. Postoperative irradiation; 3 series.

Subsequent history. In March 1935 a suspected metastasis at the point of attachment of the third rib to the sternum. On March 8, 1937, the roentgenogram disclosed a large osteoclastic defect in the upper right part of the corpus sterni. The patient was given *radiotherapy* (*teleradium; 44,000 mg. hrs over 5 fields*), and in September 1937 roentgenographic evidence of a healing of the bone lesion was obtained. The patient was subjectively free from discomfort. On November 1, 1938, she was clinically and radiographically free from symptoms.

Fig. 8. Same case as in Fig. 7, February 14, 1934, after roentgen treatment (2 series to 12 fields, about 7 200 r). Sclerotic foci in the majority of the vertebral bodies, here and there small destructions. Osteoclastic — osteoblastic phase (Stage II).

Fig. 7. Case 1. August 18, 1933. In the body of the 7th thoracic vertebra there is an evident destruction with no substantia spongiosa structure. Osteoclastic phase (Stage I), before roentgen treatment.

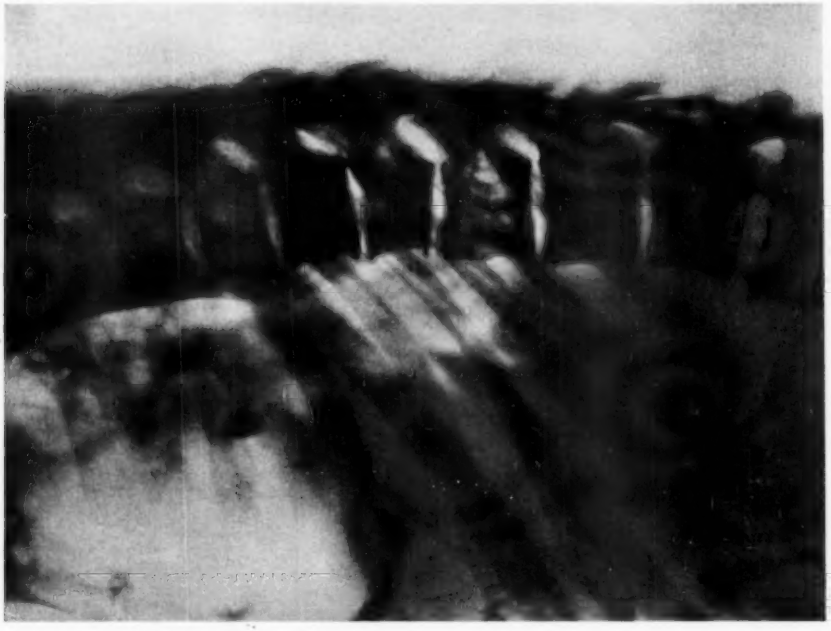

Fig. 9. Same case as in Figs. 7 and 8, December 10, 1935, about 2 years and 4 months after roentgen treatment of the metastases. The whole of the vertebral column is the seat of a pronounced sclerosis. Marble skeleton. Osteoblastic phase (Stage III).

At the conclusion of the after-examination the patient had *survived 3 years and 7 months* after the discovery and treatment of the skeletal metastases. *Still living entirely free from discomfort subjectively.*

Case 4. 1935, ♀, aged 44, A. J.

History. Since February, 1933, a growing, painful tumour in the right breast. In August, 1933, the nodule was declared to be harmless when examined at another hospital. In December, 1934, the physician was able to pronounce the tumour to be inoperable. She was not admitted to the Radiological Clinic at Lund until May 2,1935, with a fixed and lobate mammary cancer with large axillary glands; also suspected hilar changes in the lung. *Stage III.*

Treatment. Intensive roentgen treatment of the breast and axillary lymph nodes, which resulted in a considerable diminution of the tumours. After the disappearance of the reaction operation was performed on July 31, 1935. *Amputatio mammae + Exaeresis axillae.*

Subsequent history. In September, 1935, the patient complained of pain of a metastatic type, and on September 17, 1935, the X-ray examination revealed multiple osteoclastic metastatic foci in the pelvis and the left femur. *Roentgen treatment* was given

(*,800 r over 4 fields*) and a considerable improvement was noted. The patient *was able to continue at her work during the latter part of 1935 and during the whole of 1936* (*as employed as a laundress*) *and was able to walk about without any difficulty. This improved condition continued also right through 1937.* The control roentgen examination showed *an almost entire disappearance of the changes in the pelvis and the femur.* In January, 1938, the patient again complained of pain and discomfort in the left hip-joint, and the radiograms disclosed some increase in the skeletal metastases. In June the patient developed a cough, but her condition was otherwise fairly good. Roentgenological signs of pulmonary metastases. *Still alive on November 1, 1938 but condition very poor.*

Lives 3 years and 2 months after the discovery and roentgen treatment of the skeletal metastases. *Was able to continue working* and was free from discomfort for *nearly 3 years.*

Case 5. 1935, ♀, aged 43, E. A.

History. Since March 1935 a progressing nodule in the left breast. On admission the patient had a tumour as large as the palm of a child's hand in the breast with axillary nodes.

Operation on December 8, 1935. *Amputatio mammae + Exaeresis axillae.*

Microscopic examination. Scirrhous cancer simplex with infiltrated axillary glands.

Treatment. Postoperative roentgen treatment; 3 series.

Subsequent history. Metastatic pains in the pelvis and the spine since January, 1936. Roentgen examination on March 6, 1936, showed multiple osteoclastic metastases to the spine, pelvis and ribs. Several *series of roentgen treatments* were given (*3 series over 18 fields; about 17,000 r*). There was a rapid improvement and the patient *was able to work during 1936.* Roentgenographic evidence of a considerable regression of the metastases was obtained. In some parts a decrease of the lesions, an increase in the calcareous density and even a return to a normal bone structure were noted. The patient was *fully capable of working during the whole of 1937.* It was not until the end of the year that pains began to occur in the right lower leg, where the radiograms disclosed the presence of new foci, especially in the right tibia. Further roentgen treatment (*8,600 r over 10 fields*), however, did not produce any noteworthy improvement, and up to November 1, 1938, the patient has had increasing discomfort and is invalidated.

The patient had a *survival period of 2 years and 10 months* after the discovery and treatment of the skeletal metastases. Is still alive but invalidated; *was fully capable of working and relatively free from discomfort for more than 2 years.*

Case 6. 1935, ♀, aged 49, A. H.

History. Since June 1935 a growing tumour in the left breast. The nipple indrawn. On August 26, 1935, a cancer, about as large as half a tomato, was observed in the breast, involving the skin and the axillary glands.

Treatment. Postoperative roentgen treatment; one series.

Operation in December, 1935. *Amputatio mammae + Exaeresis axillae.*

Microscopic examin. Scirrhous cancer simplex; no infiltrated axillary glands.

Subsequent history. Postoperative radiotherapy. Everything went well until August, 1936, when metastatic symptoms occurred in the shape of a weakness in the left leg.

Roentgen examination on September 15, 1936: Osteoclastic and osteoblastic metastati lesions in the thoracic and lumbar vertebrae, the pelvis and the femur. *A series o roentgen treatments was instituted (4 series over 16 fields; about 9,100 r).* After repeate series of treatments to the local foci a considerable subjective improvement was noti ceable. *Very little discomfort experienced during the latter part of 1936 and during th whole of 1937 and 1938.* The patient was able to be up and about all the time an *carry on her ordinary occupation.* A considerable regression and healing tendency of th skeletal foci could be discovered in the radiographic pictures. Is still alive. On Novembe 1, 1938, her condition was good.

The patient has lived on the whole free of discomfort and *has bee able to continue working for a period of 2 years and 2 months* after th discovery and treatment of the skeletal metastases.

Case 7. 1936. ♀, aged 43, G. S.

History. Since the beginning of 1933 a slowly developing tumour in the right breast. In December 1935 pain began in the spine. On January 5, 1936, a somewhat fixed lamella-like cancer, the size of a child's hand, in the right breast. Large axillary glands. *Roentgen examination* disclosed osteoclastic carcinosis in the dorsal and lumbar vertebrae, the pelvis and the ribs. *Stage III.*

Treatment. Roentgen + radium treatment of breast + roentgen treatment of skeletal metastases (*9 fields; about 6,750 r*).

Subsequent history. A considerable improvement was noted both locally and at the site of the skeletal metastases following the radiotherapy. On December 8, 1936, the power of motion was fairly normal. The patient increased 7 kilos in weight. She felt in good health. *Roentgen examination* revealed considerable regression, sclerosis and diminution of the metastatic lesions. On October 2, 1937, the patient felt very little discomfort and the osseous changes in the pelvis had almost disappeared. In September, 1938, some pain was felt in the right thigh and right half of thorax. A subjective improvement occurred following a new series of roentgen treatments. At present the patient feels but little discomfort. Was alive on November 1, 1938.

Lives 2 years and 10 months after the discovery and treatment of the skeletal metastases almost free from discomfort and for the most part quite capable of following her regular occupation (v. Figs. 10, 11, 12, 13, 17, 18, 19).

From the above case histories it will have appeared that these cases of skeletal metastases in cancer of the breast were not only alleviated to a great extent subjectively by the series of roentgen treatments but also an objective improvement was recorded in that in addition to the changes discernible in the radiograms — which will be described more in detail below — *the survival period*[1] *was considerably longer* in these

[1] Counting from the discovery and treatment of the skeletal metastases.

Fig. 10. Case 7. January 14, 1936. Disseminated skeletal metastases in the pelvis: true osteoclastic phase (Stage I). Before roentgen treatment.

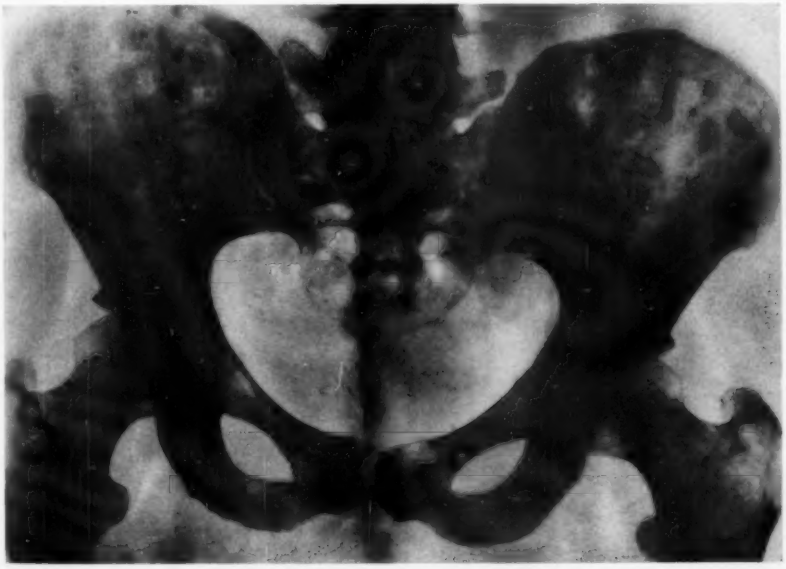

Fig. 11. Same case as in Fig. 10, June 3, 1936, after roentgen treatment (1 series, 9 fields, about 6 750 r). Multiple sclerotic foci in the entire pelvis. Osteoblastic phase (Stage III).

Fig. 12. Same case as in Figs 10 and 11, June 16, 1937, $1^1/_4$ years after roentgen treatment of metastases. Most of the sclerotic foci have disappeared, leaving behind almost normal bone structure. A few sclerotic areas remain. Osteoblastic — healing phase (Stage III—IV).

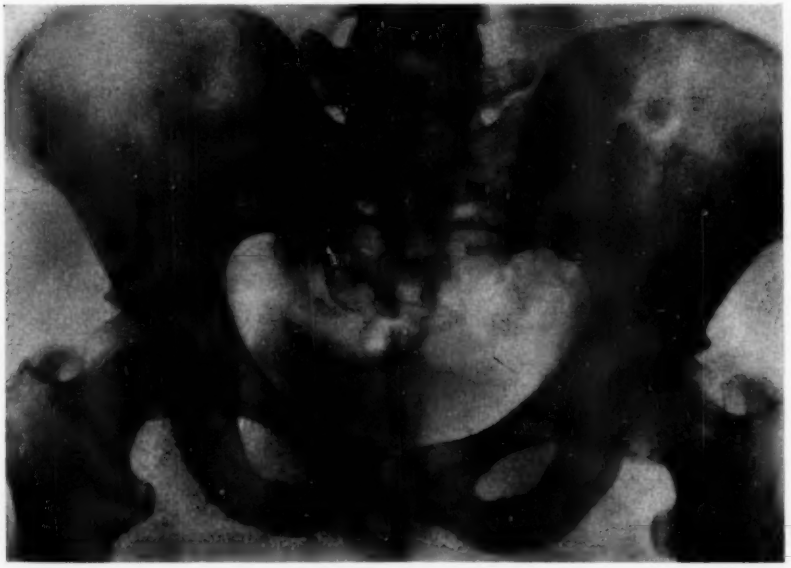

Fig. 13. Same case as in Figs. 10, 11 and 12, September 28th, 1938, 2 years and 8 months after treatment of the metastases. Nearly all foci have disappeared. Large areas of the pelvis show normal bone structure and normal calcium content. (cf. Fig. 10). Healing phase (Stage IV). The patient is still alive more than 3 years after discovery of the metastases.

cases than in the others. Thus the average survival period in these 10 cases was *33.0 months, i.e. 2 years and 7 months*, while the average survival period for the entire material was 14.3 months (as already mentioned, the survival period of the 24 cases that were apparently entirely unaffected by the roentgen treatment was 6.8 months). An examination of some of the individual cases in this group in this respect shows that in one case the survival period was 4 years and 2 months, in another case 3 years and 7 months, in a third case 3 years and 1 month, in a fourth 2 years and 7 months, in a fifth 2 years and 6 months and in a sixth 2 years and 3 months. And 5 of these 6 cases are still alive, the majority of them in a fairly good state of health.

Fig. 14. $^2/_3$ natural size. M. S. (See Figs. 4—6). Destruction in the substantia spongiosa of the vertebral body. Osteoclastic phase (Stage I) before roentgen treatment.

Besides this objectively demonstrable, rather significant longer survival period there remains the important fact that in these 10 cases an evident tendency to heal could be observed roentgenographically in the cancer metastases in the skeleton, and that in the shape of a diminution of the foci, sclerosis of the surrounding areas, increased density at or around the osteoclastic foci and finally in certain cases via an osteoblastic stage a regeneration of these defectively healed areas to a roentgenologically normal or almost normal bone structure.

This last-mentioned circumstance, this reversion of the cancerously changed areas of the skeleton in connection with the radiotherapy to an almost normal appearance (with normal bone structure) has been unmistakably demonstrated in the Lund material. Such observations have not been systematically described or mentioned previously (a somewhat similar experience has been reported only by CLARKSON and BARKER). As this feature is beautifully demonstrated in the Lund material while at the same time it shows different phases of the skeletal changes in mammary cancer in conjunction with the radiotherapy, a detailed account of these conditions is justified.

Fig. 15. $^2/_3$ natural size. Same case as in Fig. 14. After roentgen treatment. Pronounced confluent sclerosis in the vertebral body. Osteoblastic phase (Stage III).

Fig. 16. $^2/_3$ natural size. Same case as in Figs. 14 and 15 about 1 year after roentgen treatment. The sclerotic areas have almost entirely disappeared. Healing phase (Stages III—IV).

Roentgenological Pathology in Different Stages of Skeletal Metastases in Mammary Cancer: Effect of Radiotherapy

As known, the manner in which the carcinomatous skeletal metastases manifest themselves have been classified from a roentgen diagnostic point of view into the following three main forms: *a. the osteolytic or osteoclastic form*, in which larger or smaller defects are found in the substantia spongiosa or substantia compacta without any signs of reaction in the surroundings. The prototype of this form of metastasis is found most beautifully illustrated in cancer of the breast (v. Figs. 1, 10, 17); *b. the osteolytic — osteoblastic form*, i.e. a mixed form, occurring partly with defects in the skeleton in the usual osteoclastic manner and partly with sclerosis round these osteoclastic foci with calcified, spotty areas in old lesions or here and there in the substantia spongiosa. Such mixed forms are met with radiographically in mammary cancer (Figs. 2, 11) as well as in cancer of the prostate. Finally *c.* the seemingly primarily, purely *osteoblastic form* with considerable sclerosis and calcification of even large areas of the skeleton. These forms are seen most beautifully in the metastases from prostatic cancer.

From a patho-anatomical point of view, however, *every bone tumour*, primary or secondary, and consequently also skeletal metastases from cancer of the breast, *involves primarily an osteoclastic destruction of the bone tissue* (AXHAUSEN, HELLNER). Thus if cases of skeletal metastases are subjected early enough — if the foci are sufficiently large — to a roentgen examination, *all forms of tumour would be found primarily to be osteoclastic.*

Fig. 17. $^2/_3$ natural size. Case 7 (See Figs. 10—13). Detail of left ala ossis ilei. Disseminated metastases in ala. Osteoclastic phase. Before roentgen treatment.

At the same time as the destruction of the bone tissue there occurs, however, a *reactive process* of osteoid tissue formation, a new bone formation, more or less extensive and varying more or less rapidly from case to case. This process may be interpreted as the reaction and defence of the osseous system against the cancerous process. Which of the two forms of metastasis — the osteoclastic or the osteoblastic — will be the dominating one will perhaps depend on the time factor, that is, the rate at which the metastases grow. If the growth is slow there are greater possibilities of defence and consequently an increased amount of bone tissue. In such a case the osteoblastic form will predominate. If the rate of growth is rapid little new bone formation can take place, and thus we have a predominating osteoclastic form (HELLNER).

It is therefore possible that at the time of the first roentgenological examination, which certainly does not take place until a long time — perhaps several months — after the metastases have been microscopically present, certain skeletal metastases appear »primarily» to be osteoblastic (as is often the case in prostatic cancer) while others, in which the new bone formation takes place slowly, will »primarily» appear to be osteolytic, as, for instance, in mammary cancer, etc.

As pointed out above, however, *patho-anatomically speaking an initial osteoclastic stage occurs in all cases.* Consequently the customary division of skeletal metastases in cancer of the breast into different well-defined forms can only be made with respect to the occurring reaction in the bone tissue (HELLNER).

Fig. 18. $^2/_3$ natural size. Same case as in Fig. 17. 6 months after roentgen treatment. Pronounced focal sclerosis. Mainly osteoblastic phase (Stage III).

Fig. 19. $^2/_3$ natural size. Same case as in Figs. 17 and 18. 2 years and 8 months after roentgen treatment. Nearly all foci disappeared. Bone structure almost normal, likewise calcium content. Healing phase (Stage IV).

The study of the development of the metastases in the skeleton from mammary cancer also furnishes valuable information on this point.

Corresponding to the occurrence of the cancer in the skeleton (in the substantia spongiosa) the roentgen appearances are well-defined, usually multiple defects in the substantia spongiosa or substantia compacta without any roentgenologically discernible reaction in the shape of sclerosis, deposits of calcium, etc. Occasionally the cancer occurs diffusely infiltrating, especially in the vertebrae, when radiologically a very clear, almost glassy structure of the skeleton can be observed. In spite of radiotherapy a large number of cases remain in this *first stage* (v. Figs. 1, 10, 17). Of the 44 cases contained in our material (of which 42 were *primarily* — at the first roentgen examination — osteoclastic) 24 remained in this *first osteoclastic stage*, and in these cases the radiotherapy did not bring about any visible changes or signs of healing in the radiograms.[1]

[1] As known, in the great majority of cases the skeletal metastases in mammary cancer appear primarily as pure osteoclastic cases. Recent statistics (for instance, those

In some cases there spontaneously occur in the course of the disease, sometimes seemingly primarily but frequently and more markedly — as in the present writer's material — reactive bone changes following the roentgen treatment in the shape of sclerosis of the osteoclastic foci to a greater or smaller extent, thus deposits of calcium in the visible foci but also apparently irregularly here and there in the skeleton. In this way we have roentgenologically *a mixed form of partly osteoclastic and partly osteoblastic manifestations. This stage may be called a second stage* (v. Figs. 2, 11). Many cases, and certainly most cases of mammary cancer, which exhibit any reactive changes at all in the skeleton, remain in this second stage. The great majority of the 20 cases in the Lund series, in which reactive bone changes were demonstrable in the radiograms remained in this stage u s q u e a d m o r t e m.

In some of the cases of cancer metastases the development of the reactive bone changes, however, proceeds still further. The structure of the substantia spongiosa shows spotty sclerosis, the bony bridges are thickened irregularly and fuse together. In advanced cases we see *homogeneous areas of calcification, where all normal bone structure or any structure at all is absent;* we have the picture of a »marble skeleton» (in limited or more extensive areas of the skeleton) (v. Fig. 9). *This third stage* has hitherto been regarded as purely osteoblastic. No particularly pronounced cases of this type, at least not with changes distributed over wide areas, occur in our cases of mammary cancer nor in other series of a similar kind. Such pregnant pictures on the other hand are frequently met with in metastases from prostatic cancer (Fig. 9, however, shows such an advanced case of skeletal metastases in cancer of the breast).

The Lund material contains only three cases of this kind. In all of them the roentgen treatment seems to have been very effective; the survival period, too, was relatively long in these 3 cases.

A further development towards a »healing» of the pathological process may take place even before the reactive process has advanced as far as the third stage (in many cases the development never advances to more marked third stages). As already pointed out (Weisswange), such a development may consist in the previously well-defined opacities — localised to large areas or occasionally to small, well-defined foci — gradually decreasing in size in the course of months or years and finally disappearing. The occurrence of a *true* healing of the bone metastases has not so far been conclusively proved. Thus Baensch, Schinz and Friedl mention with regard to these conditions that no re-construc-

published by Hellner in 1938) give the following figures: 95 per cent. primarily osteoclastic cases, 5 per cent. mixed forms and osteoblastic cases. Lenz and Freid (1931) report 77 per cent. osteoclastic and 23 per cent. mixed forms and osteoblastic cases.

tion of these calcified areas into normal bone structure ever takes place; in the radiograms the foci always retain the character of »knöchernen Aftergebilde».

That an actual rebuilding of the calcified lesions into almost normal bone structure may take place, however, is clearly shown in several cases in the Lund material. As shown very clearly in the series of pictures 10—13, 17—19, it has been possible to follow the course of development from the stage with the pronounced true osteoclastic defects via the stage with mixed osteoclastic-osteoblastic manifestations up to the osteoblastic stage. It was possible to note how the intensive calcification gradually diminished in this last stage, *finally leaving areas which, judging from the radiograms, (patho-anatomical examinations are not yet available) exhibit pictures of almost normal bone structure* (v. Figs. 13, 19).

By demonstrating *this fourth stage* it has been possible to follow the course of development of the process apparently as far as a healing representing not a healing of a defect but the desideratum r e s t i t u t i o a d i n t e g r u m.

It was explicitly pointed out above that from a patho-anatomical point of view there is essentially no difference between the different forms of metastases in mammary cancer (or any other kind of skeletal metastases). The above series of radiograms of the phases of development also show quite plainly that there exist all kinds of transitions from one stage to the other, and therefore *all the various metastatic manifestations are simply stages or phases in a uniform process of development from purely primary osteoclastic foci to — in favourable cases — a complete healing to a r e s t i t u t i o a d i n t e g r u m.*

That several circumstances, such as the different modes of growth and degrees of malignancy of the tumours, differences in the mode of reaction of the affected individuals, varying effects of the therapy, etc., cause a varying number of cases to persist in the different stages of development is therefore more than probable, and this blurs the picture of the uniform development.

Discussion

From the preceding analysis of radiologically treated cases of skeletal metastases it will have appeared that the results obtained, both with respect to the subjective and the objective improvements, were very variable. This prompts us to investigate the possible causes of these varying results. Is this variation due to the primary material or to the treatment? Is the cause to be found in the course of the disease or is the therapy itself responsible for the heterogeneous results? Can anything be done to bring about an improvement of these results?

The *nature of the primary material* with respect to the distribution of the cancer at the first medical examination is shown in the following table. In this table Group I represents the unfavourable cases in our material (54.5 per cent.) with an average survival period of only 6.8 months and in which no subjective or objective evidence of improvement was observed. Group II (45.5 per cent.) contains the favourable cases with a relatively long survival period, amounting on the average to 23.4 months, and exhibiting evident signs of subjective and objective improvement. The table shows quite plainly that the primary material in Group I was much inferior to that in Group II, Group I containing 58.3 per cent. of the material in STEINTHAL's *Stage III* and only *41.7 per cent. in* STEINTHAL's *Stages I and II*. The corresponding figures for Group II were 30 per cent. in Stage III and *70 per cent. in Stages I and II*.

	Steinthal I	Steinthal II	Steinthal III
Group I	12.5 %	29.2 %	58.3 %
» II	15.0 »	55.0 »	30.0 »

In a primary material of malignant tumours age does as a rule play rather a great part in estimating the prognosis, for in younger ages cancerous processes in general seem to be of a more malignant type than in older ages. In this metastatic material the average age in the unfavourable group, Group I, was 56.8 years while in the favourable group, Group II, it was 48.3 years (in the entire material 51.5 years). *Thus we have here inversed relations.*

This circumstance is interesting and worth calling attention to. In a similar series reported by LENZ and FREID analogous conditions seem to have been present. With a certain reservation for the small number of cases in the Lund material an attempt might be made here to find an explanation. In these cases it relates to the *treatment of the metastases*. The reactive power of an individual to traumata and foreign agents, as far as the osseous system is concerned, may be said to be greater in younger ages than in older, judging from observations made in several other fields. The roentgen treatment given in these metastatic cases had a destructive or inhibiting effect on the tumour process itself, therefore the natural healing tendency of the skeleton in these cases should show to better advantage. This perhaps affords a clue to the better results obtained in the treatment of the younger metastatic cases in this series and in those reported by LENZ and FREID.

The pathological anatomy of the primary tumour in these cases of mammary cancer and its relation to the rate of growth and the susceptibility of the skeletal metastases to radiotherapy have already been dealt with in

a number of works. GESCHICKTER and COPELAND, LENZ and FREID and others considered that they were able to prove that in »favourable» cases of skeletal metastases the cancer usually appeared as a scirrhous cancer. In our material, the cases of which are grouped in the table according to the course of the disease and the pathological anatomy, no marked or even noticeable difference in this respect can be discovered in the unfavourable Group I or the favourable Group II.

	Scirrhous cancer	Cancer simplex or medullary cancer simplex	Adenocarcinoma	Paget's disease
Group I	5 cases	5 cases	2 cases	0 case
» II	6 »	6 »	1 case	1 »

Finally, as regards the *treatment of the primary material* — here in the shape of pre-operative or postoperative roentgen treatment — the question may be asked whether such a prophylaxis has *any bearing on the subsequent treatment and course of the bone metastases.* It is a difficult matter to give a definite reply to this question or even to furnish any reply at all without having very extensive statistics available. It may, however, be worth while pointing out also in this connection that of the 32 cases (out of a total of 44) in which a radical operation of the primary tumour was performed, 17 belonged to the unfavourable Group I. Only 6 of these 17 cases had received prophylactic roentgen treatment (pre-operative treatment in 1 case and postoperative in 5 cases). On the other hand of the remaining 15 primarily operated cases that could be classed in the favourable group, 11 had received prophylactic roentgen treatment (3 pre-operatively and 8 postoperatively). Thus the number of cases in the favourable Group II that had received prophylactic radiotherapy was much higher than in the inferior Group I.

As appears from the analysis above, there are considerable differences between the *survival periods* in the favourable Group II and the unfavourable Group I. In some of these metastatic cases it is easy to judge the prognosis in regard to the probable term of life of the patient — for instance, in extensive, far advanced changes — but in other cases and perhaps in most cases it is difficult. Do the course of the disease and the time of the onset of the metastases or any other data furnish us with any definite clues by means of which it is possible to form an idea of the prospects and the advisability of therapy? In the works of LENZ and FREID and of GESCHICKTER and COPELAND a definite correlation has been found between the interval occurring between the discovery of the primary tumour and the onset of the skeletal metastases and the final survival period.

On the basis of a relatively large material these authors found the longer the interval between the discovery of the primary tumour and the onset of the skeletal metastases the longer will be, generally speaking, the survival period[1].

This interval, which is of great clinical importance (When may the bone metastases as a rule be expected to appear?), has also been investigated in the Lund material. As in all series of this kind a certain reservation must be made, as for very obvious reasons the time of the discovery of the primary tumour and the time of the discovery of the metastases are always very inexact.

In the entire Lund material the mean interval between the first discovery of the mammary cancer and the onset of the skeletal metastases was 18.8 ± 6.6 months (if twice the standard error is taken the time interval within which the skeletal metastases may be expected to appear will be *between 6 and 30 months*). In the unfavourable Group I the mean interval was 14.8 months and the survival period was 6.8 months. In the favourable Group II the interval was 23.6 months with a survival period of 23.4 months. Thus our material, too, demonstrates the correctness of the rule that *»the longer the interval between the discovery of the primary tumour and the discovery of the skeletal metastases the longer will be the survival period.*

In every account of the results of therapy *the therapy itself*, its variations, etc. must be subjected to a close examination. It has already been pointed out that during all the years the roentgen treatment was practically uniform. A further analysis of the cases in the different prognostically favourable groups goes to show that there is no noteworthy difference as far as treatment is concerned. Judging from the Lund material and from similar materials and cases reported by other investigators (LENZ and FREID, GESCHICKTER and COPELAND, v. BERGEN, SUNDBERG, and others), the dosage administered in the roentgen treatment apparently *does not play any decisive rôle in the end-results.* Those cases which react favourably appear to do so even to small or moderate roentgen doses (Focal doses of 750—1,000—1,500 r). Large and intensive series of treatments seem, if anything, to do more harm than good.

The above analysis of the possible causes of the varying course of the roentgen treated cases of skeletal metastases is not absolutely complete nor does it furnish convincing proof or definite indications for conducting future investigations. Nevertheless the results obtained seem to warrant our drawing the conclusion that *the nature of the primary material* in relation to the spread of the tumour process is of relatively great

[1] Counting from the discovery of the metastases.

importance in the subsequent course of the metastatic cases, that the estimation of the interval between the discovery of the primary tumour and the discovery of the metastases is of value in judging the prognosis, and finally that perhaps a prophylactic roentgen treatment has also some influence on the course of the metastatic cases.

A logical sequence of the analysis is the desideratum that *metastatic cases should be given radiation treatment as soon as possible* and consequently that the metastases should also be diagnosed — by sending suspected cases for roentgenological examinations — if possible at an earlier stage than formerly.

The results obtained in the treatment of this series of cases are, even if only palliative, nevertheless encouraging. But it must be emphasized that the importance of the roentgen treatment in these cases, both as regards the longer survival period and the roentgenologically visible evidence of healing, should not be overestimated, for cases are on record in which the skeletal metastases without any treatment at all have shown a tendency to sclerose and a few cases have been described in which the metastases spontaneously improved to a great extent and partly regressed. In those cases of the Lund material which reacted favourably to the roentgen treatment, amounting to 22.7 per cent., the changes, however, were so evident, subjectively and objectively, that one had *a strong impression that it was the roentgen treatment which caused or at any rate greatly accelerated the process of healing*[1].

SUMMARY

In a series of 44 cases of mammary cancer with skeletal metastases in which the metastases had been subjected to a simple fractional roentgen treatment, in 54.5 per cent. of the material no, or only uncertain, subjective improvement could be discerned; objective evidence of such an improvement was missing altogether. In 45.5 per cent. of the material a good, in certain cases very striking, subjective improvement was noted. The subjective improvement in these cases corresponded to objectively discernible changes in the radiograms, indicating the delimitation of the cancer process in the involved parts of the skeleton — the sclerosing of the foci and in 3 cases even a roentgenological healing or previously discernible changes with a regression to almost normal bone structure.

The demonstration — roentgen diagnostically — in this material of mammary cancer of all transitions from one form of skeletal metastases to another, from the pure osteoclastic phase finally to the almost complete healing, together with the fact that from a patho-anatomical point of view there is essentially no difference between the different forms of metastases, make it obvious that all the different manifestations of the skeletal metastases are simply stages or phases in a uniform process of development and are not to be regarded as definite, independent types.

[1] Further investigations of these problems appear to show quite definitely that radiotherapy is of vital importance in the rapid and pronounced appearance of the healing process.

ZUSAMMENFASSUNG

In einer Serie von 44 Fällen von Carcinoma mammae mit Skelettmetastasen, bei denen die Metastasen durch einfache fraktionierte Röntgenbestrahlung behandelt wurden, war in 54.5 % des Materials keine oder nur eine unsichere subjektive Besserung festzustellen; objektive Zeichen einer solchen Besserung fehlten völlig. In 45.5 % des Materials war eine gute, in gewissen Fällen erstaunliche subjektive Besserung zu verzeichnen. Dieser subjektiven Verbesserung entsprachen in diesen Fällen im Röntgenogramm festzustellende objektive Veränderungen, die auf eine Abgrenzung des carcinomatösen Prozesses in den angegriffenen Skeletteilen hindeuteten — Sklerosierung der Herde, in 3 Fällen sogar röntgenologische Ausheilung früher beobachteter Veränderungen mit annähernder Wiederherstellung der normalen Knochenstruktur.

Der — röntgendiagnostische — Nachweis aller Übergänge zwischen den verschiedenen Formen von Skelettmetastasen in diesem Carcinoma mammae-Material, von der rein osteoklastischen Phase bis hin zur fast vollständigen Ausheilung, sowie der Umstand, dass sich pathologisch-anatomisch kein prinzipieller Unterschied zwischen den einzelnen Metastasenformen aufrechterhalten lässt, dürften klarlegen, dass alle diese verschiedenen Manifestationen der Skelettmetastase einzig und allein Stadien oder Phasen eines einheitlichen Entwicklungsverlaufes und nicht als verschiedene abgegrenzte Typen zu betrachten sind.

RÉSUMÉ

Dans une série de 44 cas de cancer mammaire avec métastases squelettiques, où les métastases furent soumises à un traitement roentgen fractionné simple, on constata une amélioration subjective nulle ou incertaine dans 54.5 % du matériel; les signes objectifs d'une telle amélioration firent totalement défaut. Dans 45.5 % des cas, on constata une amélioration subjective, parfois même frappante, à laquelle correspondaient également des changements objectivement discernables sur les roentgenogrammes, indiquant la délimitation du procès cancéreux dans les parties squelettiques atteintes. Dans 3 cas, on constata même une guérison roentgenologique d'altérations antérieurement discernables, avec régression vers une structure osseuse à peu près normale.

La démonstration — roentgendiagnostique — dans ce matériel de cancer mammaire, de toutes les transitions entre formes diverses de métastases squelettiques, depuis la phase purement ostéoclastique jusqu'à la guérison finale à peu près complète, jointe au fait qu'on ne peut, au point de vue pathologique-anatomique, maintenir aucune différence de principe entre les différentes formes de métastases, paraissent rendre évident que toutes les différentes manifestations de métastase squelettique ne constituent tout simplement que des stades ou phases d'un procès d'évolution uniforme, et ne sont donc pas à considérer comme des types indépendants et distincts.

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A CASE OF ADENOSARCOMA OF THE KIDNEY (WILMS'S MIXED TUMOR)[1]

by

Johs. Agerholm-Christensen

Adenosarcoma of the kidney seems to be a comparatively rare disease. A search through the literature, by McNEILL and CHILKO, in 1938, shows a total of 383 cases published. FRASER, after going through 15,000 children's journals, estimates its frequency among that age-group to be 0.05 per cent of cases; DEAN and PACK state that of all their cases of malignant tumor it represents only 0.096 per cent. Nevertheless it is said to be the second in frequency among malignant tumors in children, and, of malignant tumors of the urogenital system, the one most frequently met with in that age. The etiology and pathogenesis of the disease are still a matter of controverse, and year-long researches are even yet being devoted to elucidating the problem. Most of the investigators adhere to one of three theories: that the tumor develops from aberrant cells from the myo- and sclerotome (WILMS et al.); or from the Wolff'ian body (BIRCH-HIRSCHFELD et al.); or from the renal blastema (EWING et al.).

The characteristics of the tumor are as follows. Its origin is embryonal, and it arises from the renal cortex. From thence it grows expansively in the direction of the pelvis, compressing the normal parenchyma, calyces and pelvis of the kidney, but without rupturing either the capsule of the latter or the pelvic wall. Only in exceptional cases does its growth become infiltrating along the ureter and the vessels. The primary growth is thus comparatively undisturbing; on the other hand it very often recurs *in loco*, and then with malignantly infiltrating growth through the peritoneum, the pancreas and the adjacent organs. As regards the incidence of metastases, the statements vary; by some they are said to occur in as much as 50 per cent of cases, while MIXTER, KRETSCHMER and HIBBS, and DEAN and PACK speak of them only in connexion with large

[1] Submitted for publication Nov. 28, 1938.

tumors. They are chiefly to the liver and lungs, more rarely to the other kidney (according to WILMS in 7.2 per cent of cases, according to KRETSCHMER and HIBBS in 12 per cent), and to the bone system. The microscopical picture is variegated, presenting a more or less pronounced mixture of smooth and striated muscle cells, cylinder epithelia, rudimentary glomeruli, cartilage, connective tissue fibrils and nerve elements in malignant arrangement.

Though several cases have been reported in adults, the disease is essentially one of childhood. As a rule, it is recognised before the age of seven, most often about the third year, not infrequently already in the first year of age. It occurs with equal frequency in both sexes. The case-histories and clinical pictures reported show a striking similarity, and very closely resemble those of our case. Up to a certain late point of its development, the course of the disease is markedly insidious. As a rule, it is the accidental observation that the child's abdomen has grown larger which causes the parents to consult the physician. There is seldom any pain; all the authors by whom that symptom has been found in any fairly considerable number of cases put emphasis on the fact that at any rate such pain has been of an indefinite, pressing character, and therefore hardly likely to arouse the attention of those having care of the child. In some cases there has been noticed a certain lassitude, and possibly some loss of appetite with consequent loss of weight; in others slight attacks of vomiting and intestinal disturbances, specially obstipation. But the point which must be particularly emphasised is that, in contradistinction to what is the case in adult patients with kidney tumors, there has very seldom been observed either disturbances of the micturition or macroscopic hematuria (MIXTER, DEAN and PACK, FRASER). Unfortunately, as a result of this the child's condition is nearly always brought to the doctor's attention very late. The influence on the general condition differs, of course; a certain degree of anemia and emaciation is not unusual; in many cases there is an elevation of temperature above the normal.

Locally, there is a palpable mass in the flank or one side of the abdomen. In the early stages it is smooth, firm and displaceable, pushing the colon over towards the middle; later it may become more lumpy, and in case of necrosis softer or even fluctuating. Examination of the urine often gives a negative result; there is seldom hematuria, more often albuminuria, sometimes intermittent. Examination of the blood usually shows nothing abnormal except low hemoglobin values. Pyelography, on the other hand, may be expected to give some information. But as this method of examination is comparatively new, and as the small number of cases (10 to 20) observed by most of the investigators have often been collected by them over periods of from ten to twenty years, results of such examination are reported by very few. In the literature available

to me, I have found only about twenty cases in which the method was essayed. Besides, direct pyelography will often be impossible owing to mechanical obstructions, and intravenous pyelography compromised by failing renal function. As, furthermore, the examination in the majority of cases was undertaken at a very advanced stage of the pathological development, it is not surprising that in a great many of them no pyelogram could be obtained. Roentgen examination will always show a mass producing more or less shadow, and displacing the viscera in corresponding degree. Where the pyelography has been successful, the two changes oftenest found have been (1) dislocation, perhaps torsion, of the pelvis and calyces, and (2) a lengthening and attenuation of both of these portions; but no signs of infiltration.

The treatment has in most cases been nephrectomy or roentgen, or a combination of both. The prognosis has everywhere been bad; the mortality is stated to be about 90 per cent or more. It is difficult, of course, from a material of such diverse provenance and so diversely handled to judge what treatment should be preferred, but the balance of opinion seems to be in favor of nephrectomy combined with roentgen. The primary mortality from operation varies from 0 to 20 per cent; but many believe that this may undoubtedly be lowered if certain precautions are observed. Large tumors should be reduced by pre-operative roentgen treatment. The operation should be done by pararectal incision and transperitoneally; and stress is laid on the great importance of blood transfusion in connexion with careful arrest of bleeding.

Our own case was not a suitable one for operation, if only for the reason that the affection was bilateral. The history is as follows.

Journal no. 18118. — K. B., male, 8 months old. — On May 1st the mother suddenly discovered that the left side of the child's abdomen was plumper, more distended than the right. With exception of sluggish, scanty defecation there had been no previous signs of illness. During the following days there came a few vomitings. On May 5th the child was admitted to the Radium Hospital. It was pale, the abdomen was distended; there was dulness in both flanks. In the left side could be felt a round, firm, ballotting mass, the size of a child's head; in the right side, posteriorly, a corresponding mass, the size of an orange. The temperature was slightly above the normal. A complete blood examination showed simple anemia, with 37 per cent hemoglobin. Precipitation 1 mm/h.. Urine free from albumin, blood, pus and sugar (no microscopy). Blood urea 24 mg. per cent. Mantoux negative. Roentgen examination of the lung showed normal conditions. Roentgen examination of the abdomen, with pyelography after intravenous injection of 3 ccm. of uroselectan B, showed both in frontal and lateral projection the cavity distended. The gas-inflated colon was displaced forwards and towards the right by a large shadow-giving mass, probably situated extraperitoneally, and which filled the entire left and posterior part of the abdomen. The pelves and calyces on both sides were fairly well filled; the kidney shadows could not be made out with certainty. The left pelvis lay horizontally, in anterior-posterior direction. There was no certain pathological alteration of its shape, nor any noticeable dislocation. The right pelvis was situated far towards the

back; it was very flat from before backwards, with long, slender calyces; the distance from the uppermost to the lowest was 8 centimeters.

Roentgen treatment was instituted, but was made difficult by the rapidly declining condition of the child. The temperature became jumpy; at the same time the tumor in the left side grew larger; cutaneous vein tracings appeared on the abdomen, and slight edema on the thighs. On July 20th the child died.

Necropsy report (ENGELBRETH-HOLM, M. D.): Small, pale child, very emaciated. Abdomen large, distended. In the peritoneal cavity a very small quantity of clear fluid. All the intestines displaced towards the right by enormous tumor in the left side.

The right kidney is transformed into a large oval, slightly buckled tumor, 20 × 11 × × 9 cm. large, weighing 950 grams. The tumor is not adherent to its surroundings. In section, it is seen to be whitish yellow, soft, homogeneous, with rather large reddish brown, speckled necroses. Renal tissue is found immediately adjacent to the well preserved pelvis, which lies flattened and stretched out on the medial side of the tumor and corresponding to the superior pole, where there rests a block containing a pyramid, and a narrow border on the posterior side. On incision, large, round, smooth sections of tumor are seen to project into the pelvis.

The left kidney weighs 240 grams, and contains white, soft, confluent masses of tumor, 4—5 cm. large, partly necrosed. Intact renal tissue is found as a limited mantle on the upper and posterior surfaces of the neoplastic conglomerate. Posteriorly and medially in this renal tissue is found the somewhat flattened pelvis.

In various parts of the liver there are metastases, 3 × 3 cm. large, resembling renal tumor. A similar, small, metastasis is found in the inferior part of the lower lobe of the right lung. The suprarenal glands and other organs show normal conditions.

Microscopy. — Sections of tumor from the left kidney are composed of mesenchymal tissue very rich in cells. Between looser strata with scattered collagenous fibrils there are compact heaps, streaks and larger masses of tissue composed of small, closely packed undifferentiated, round or spindle-shaped cells, containing very little cytoplasm. The nuclei are relatively large, and of fairly regular shape, without particular characteristics. Towards the centre there are necroses here and there. The tissue resembles an embryonic mesenchyma. Scattered through it there are small, irregularly branched epithelial formations with closely-set, very dark epithelial cells, cubic or cylindrical, also of embryonic character. These formations have no membrana propria out towards the other, mesenchymal tissue. The vascular supply in the tumor is scanty, but in some parts there are extensive hemorrhages. Close against the tumor lies normal renal tissue, considerably compressed, so that all canals lie parallel to the surface of the tumor. Also the glomeruli are oblong and oval. The frontier between the renal tissue and the tumor is marked by a thin membrane of connective tissue, which is pierced in a couple of places.

Sections of the tumor of the right kidney show the same picture; with the exception that here the tumor is less rich in cells, and the adenomatous element conspicuous, in some places with large cystic sections, into which rather coarse, papillomatous excrescences protrude themselves. The stroma is more abundant, in several places rich in cells and almost sarcomatously whorled.

Sections of the metastases in the liver show exactly the same structure, though here with preponderance of the tumor's mesenchymal component and only a few glandular tubules. There is distinct invasive growth into the surrounding hepatic tissue.

The metastasis in the lung shows the same picture. There is extensive diffuse bleeding in the tumor. The demarcation from the surrounding atelectatic lung tissue is in some places sharp, with a thin capsule of connective tissue, in others vague, with invasive growth. The suprarenal gland shows normal conditions.

Diagnosis: *Adenosarcoma of the left kidney (Wilms); metastases in the right kidney, the liver and the right lung; emaciation; anemia; dislocation of the viscera.*

I report this case, which I believe is the first one in the Danish literature, not as a curiosity, — even though the bilateral tumor is very rare, — but in order to draw attention to the existence of the disease, specially to its insidious development (notice, for instance, the failure of urinanalysis), and to point out that in pyelography we undoubtedly possess an aid to its earlier recognition.

SUMMARY

The author reports a case of bilateral adenosarcoma of the kidney (Wilms's mixed tumor), with metastases to the liver and lung, in a child 8 months old. Roentgen treatment was instituted, but the patient died 2 months after admission to the hospital. The necropsy- and microscopical findings are given in detail.

On the basis of the existing literature, the characteristics of the tumor are recounted Owing to the sneaking development and especially the failure of urinanalysis, most of these cases are not brought to the physician's attention until in a vary advanced stage. In pyelography we possess a valuable aid to earlier recognition and diagnosis of this disease.

ZUSAMMENFASSUNG

Verf. berichtet über einen Fall von bilateralem Adenosarkom der Niere (Wilmsche Mischgeschwulst) mit Leber- und Lungenmetastasen bei einem 8 Monate alten Kind. Es wurde Röntgenbehandlung eingeleitet, der Patient starb aber 2 Monate nach der Spitalsaufnahme. Die Obduktions- und mikroskopischen Befunde sind im Detail wiedergegeben.

Sodann bespricht Verf. an der Hand der vorliegenden Literatur die charakteristischen Merkmale des Tumors. Infolge des schleichenden Verlaufes und besonders des Fehlens der Harnanalyse sind die meisten von diesen Fällen bereits in sehr vorgeschrittenem Stadium, bevor sie zu einem Arzt gebracht werden und dessen Aufmerksamkeit erregen. In der Pyelographie besitzen wir ein wichtiges Hilfsmittel zu früherer Auffindung und Diagnostizierung dieses Leidens.

RÉSUMÉ

L'auteur rapporte un cas d'adénosarcome bilatéral du rein (tumeur mixte de Wilms), avec métastases au foie et au poumon, chez un enfant de 8 mois. Un traitement roentgen fut appliqué, mais le sujet décéda 2 mois après son admission à l'hôpital. Les constatations à l'autopsie et au microscope sont exposées en détail.

Les caractéristiques des tumeurs en question sont récapitulées sur base de la littérature existante. En raison de leur évolution insidieuse et, surtout, de l'absence d'analyse d'urine, la plupart de ces cas ne sont soumis à l'observation du médecin qu'à un stade très avancé. La pyélographie nous fournit une aide précieuse pour la reconnaissance précoce et pour le diagnostic de cette affection.

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FROM THE LIGHT THERAPY DEPARTMENT. ODENSE AMTS OG BYS SYGEHUS, ODENSE, DENMARK. CHIEF: P. JACOBY

DIRECT OR ALTERNATING CURRENT ARC LAMPS FOR LIGHT THERAPY?[1]

by

Axel Saugman

The answer to this question is obvious, if direct current only is available. I will hardly ever be advantageous to convert direct current in alter-nating.

If, however, alternating current is supplied, the matter is quite different, and the answer is of great economical importance.

First of all, we have, of course, to consider the patients, and we have to ask ourselves, whether satisfactory therapeutic results may be obtained with alternating current arc lamps.

In Denmark, this question has usually been answered in the negative, and great amounts of money have been invested in expensive rotary converters, necessary for direct current installations. This was right and proper, so long as it was customary to use plain carbons only, having a very inferior efficiency if run by alternating current. The ultraviolet emission is reduced, while the heat remains the same.

Since the value of flame carbons in light therapy has been proved by LOMHOLT, the situation is quite another. The efficiency of the flame carbons is very nearly as great with alternating as with direct current, and is, by the way, more than twice the efficency offered by plain carbons.

The difference in the distribution of energy in the spectrum, between white flame carbons, fed by direct, and alternating, current, has been investigated by COBLENTZ. At about 3,000 Ångström, that is, at the wawe-length, which is of particular interest for light therapy, he finds no difference. The cyanide lines are about 25 % lower in the case of al-

[1] Paper read before the Northern Association for Medical Radiology, at the meeting in Copenhagen, June 1938.

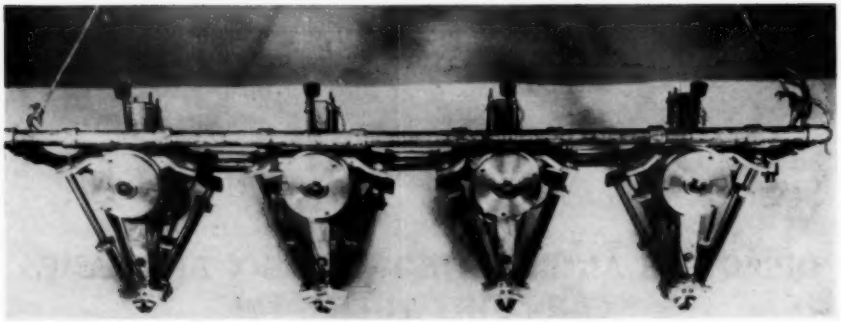


Fig. 1.

ternating current, and in the red and infra red there is an increase of about 20 %.

This may mean a somewhat lower efficiency, but the difference will be small, not above 20—25 %, probably less.

The loss will be compensated by the greater efficiency of the transformer and choke coil, compared with that of the rotary converter and ballast resistance.

There is, as will be gathered from the above, no objections of any importance, against the use of alternating current for light therapy arc lamps, if they are fitted with flame carbons.

The light therapy arc lamp should be simple, sturdy, and reliable, and, as far as we can se, these conditions are best answered by lamps, built on the four-converging-carbon principle, extensively used for street lighting and other purposes some 25 or 35 years ago.

Two 20 amperes lamps of this sort have now been in dayly use at our clinic for more than half a year, and several thousand treatments have been given with these lamps.

They have proved entirely satisfactory, and more reliable than the usual arc lamps with differential feed.

The figure shows a set of four 50 amperes alternating current arc lamps, built on the principle, mentioned above, and intended for use in a solarium, which will be fitted with 16 of these lamps.

SUMMARY

The merit of direct and alternating current arc lamps for light therapy is discussed. The author concludes, that the small advantages, offered by the direct current lamps. does not justify the much greater expense involved.

ZUSAMMENFASSUNG

Verf. erörtert den Vorteil von Gleich- oder Wechselstrom-Bogenlampen für Lichttherapie. Verf. kommt zu dem Schluss, dass die kleinen Vorteile, die die Wechselstromlampen bieten, die durch sie bedingten viel grösseren Kosten nicht rechtfertigen.

RÉSUMÉ

L'auteur discute des mérites respectifs des lampes à arc pour courant continu et pour courant alternatif en héliothérapie. L'auteur conclut, que les légers avantages offerts par les lampes à courant continu de justifient pas l'accroissement considérable de dépense qu'elles impliquent.

FROM THE ROENTGEN DIAGNOSTIC DEPARTMENT OF LUND HOSPITAL, SWEDEN.
CHIEF: HANS HELLMER, M. D.

AN AID TO THE ROENTGEN DIAGNOSIS OF EWING'S SARCOMAS[1]

by

Sölve Welin

In 1922 EWING published his new classification of the bone tumors. At this time he classified a new homogeneous group of tumors as endothelioma, but these soon came to be known as Ewing's sarcoma. EWING maintained that these sarcomas have a very typical radiographic appearance, are very radiosensitive, usually occur in people who are less than 20 years old, and have a fairly characteristic clinical picture with pains of the interval type, history of trauma, palpable tumor and remittent temperature.

Histopathologically the tumors are round cell sarcomas with frequent mitoses and little intercellular substance. There has been a great deal of argument concerning the histogenesis of these tumors; thus EWING originally considered that they were derived from the vessel endothelium in the bone marrow, as in several cases he had found elongated cavities which were filled with intact blood and surrounded by tumor cells. In a later work, however, he wrote that they did not originate from the endothelium of the blood vessels but from that in the perivascular lymph vessels. GESCHICKTER and COPELAND thought that the tumors had a subperiosteal or intracortical origin and that they thus were initiated in the periphery of the bone. AXHAUSEN considered them to be hyperplastic granulomas, while HIRSCH and RYERSSON thought cancer metastases were in question. Now, however, most pathologists are of the opinion that these tumors originate from more or less differentiated reticular cells in the bone marrow. CONNOR, OBERLING and HELLNER are among those of this opinion, while BERGSTRAND thinks that they are caused by a perturbation of the mesenchymal blastema in the early foetal stages.

[1] Submitted for publication 7. I. 1939.

The diagnosis of Ewing's sarcoma is based upon clinical, radiological and histological factors. The following essay is intended to contribute to the roentgen diagnosis of Ewing's sarcoma and is founded on the experience from the Lund clinic during the years 1932—1938. In this period we have had the opportunity to examine 9 cases of this disease thoroughly. A survey of the material is given in the following table.

Patient	Age	Diagnosis on admittance	Primary location	Metastases	Duration of the disease	
					Total	After the beginning of radiotherapy
I. L. ♂	1 1/2 year	Inflammatory process	Os temporale	Scapula Pelvis Kidney	90 1/2 months (still alive)	90 months
S. F. ♂	13 years	Bone tumor	Os pubis	Skull Spine Pelvis Femur	20 months	1/2 month
K. P. ♂	54 years	Osteomyelitis	Right femur	Pelvis	11 months	4 months
A. Ö. ♂	71 years	Tumor	Os frontale	Lungs	17 months	16 months
E. P. ♂	34 years	Sciatica	Left femur	Skull Humerus	20 months	8 months
K. O. ♂	14 years	Bone tumor	Left fibula	Skull Spine Pelvis	23 months	20 months
A. S. ♂	29 years	Bone tuberculosis	Right femur	Pelvis	35 months (still alive)	11 months
I. H. ♂	13 years	Malignant tumor of left tibia	Left humerus	Tibia Skull Spine Left femur Lungs	34 months	7 months
G. K. ♂	28 years	Rheumaticus acuta	Os occipitale	Skull Left humerus	15 months	10 months

The primary tumors are usually localized to the long bones, but they can be situated in any bone, as can be seen from the above table. If they occur in the long bones, they usually affect a considerable part of the shaft in a relatively short time. Formerly, the opinion was that the changes occurred in the diaphysis or metaphysis, but they have also been demonstrated in the epiphyses.

The disease is characterized by early metastases to the skeleton, the ribs, the skull, the vertebrae and the pelvic girdle being the sites of predilection, though metastases can be found in the long bones as well. Very seldom will any other bone tumor affect the rest of the skeleton.

Ewing's sarcoma also metastasizes to the regional lymph glands and the internal organs. The metastases localized to the internal organs usually appear much later than the others and there may be an interval of a year between the appearance of the bone metastases and these.

In discussing the roentgenological appearance of Ewing's sarcoma, it is important to distinguish the primary from the metastatic sites. It should be mentioned at this point that generally only the combination of the typical picture of the primary tumor and the picture of the skeletal metastases can give an exact roentgenological diagnosis. A complete examination of the whole skeleton of the individual has thus to be made.

The roentgen-ray photograph of the primary site is characterized by an elongated, diffusely defined, more or less central patchy destruction and pronounced periosteal accumulations. This roentgenogram is a reflection of the pathologico-anatomic basis: the original localization in the bone marrow can cause either a well defined central lysis of the spongiosa (HELLNER), or else an increased density of the bone, as the tumor cells, besides a complete destruction of the bony tissue, also cause a reaction in the form of new growth of the bone (GESCHICKTER and COPELAND). There is no radiogram of this early stage in our material. The process than rapidly extends in the long axis of the bone, causing destruction as well as new growth and therefore a roentgenogram is often obtained in which spot-shaped areas alternate with denser parts. The tumor cells also grow through the Haversian canals to the periosteum, and lamellar or, rarely, spicule-shaped periosteal accumulations appear that may rapidly attain a considerable extent. For example, in case no. 2, we find extensive bulbous accumulations (Fig. 1) and in case no. 6 we have the spicule type. (Fig. 2.)

The changes characteristic of the primary tumor are most apparent when the tumor is situated in the long bones, but even when localized to the flat bones, it is possible to make the diagnosis. (Fig. 3 and 4.) It is evident, however, that localisations may appear in the spinal column and the os temporale, for instance, where it is impossible to demonstrate the above-mentioned characteristics of a primary tumor. BULL ENGELSTAD has published two of these instances with the primary tumor in the os calcaneus and in a vertebra, where the diagnosis was made only after histological examination.

There are no specially characteristic roentgenographic features of the skeleton metastases, except that they are predominantly osteolytic. Yet there can also be an element of reactive new growth of the bone, as the following preparation picture from the os ileum of case 2 shows. (Fig. 5.) In the metastatic areas in the long bones periosteal stratifications have been found.

Fig. 1. Case II. The primary tumor in ramus superior os. pubis sin. with elongated central destruction and extensive bulbous periosteal stratifications.

Fig. 2. Case VI. The primary tumor in fibula si[n]. with central destruction and both lamellar a[n]d spicule-shaped periosteal stratifications.

Fig. 3. Case IV. The primary tumor in the frontal bone with destruction of the outer table of the skull and lamellar periosteal stratifications.

Fig. 4. Case IX. The primary tumor in the occipital bone with destruction of the outer table of the skull and with spicule-shaped periosteal accumulations.

Fig. 5. Case II. Metastases in ilium with an element of reactive new growth of the bone.

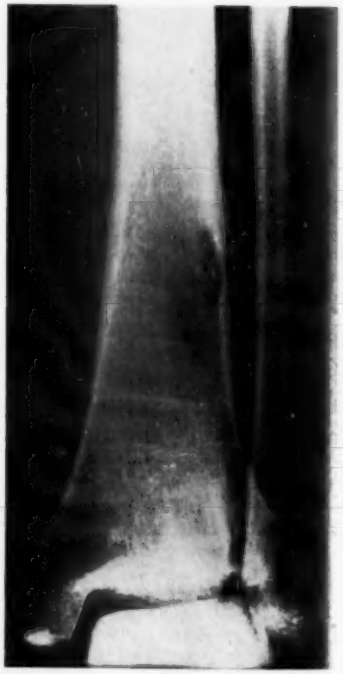
Fig. 6. Case of osteomyelitis. $^{17}/_{9}$ 1938. A rounded, well-defined attenuation of the bone with some periosteal stratifications on the level of the destruction.

Fig. 7. Case of osteomyelitis. $^{6}/_{10}$ 1938. The two sequestra appear more clearly. The periosteal stratifications have further increased.

Fig. 5.

Fig. 6.

Fig. 7.



The differential diagnosis of the primary tumors of the Ewing's sarcoma is often very difficult, sometimes even impossible. In the first place it is necessary to consider the specific and nonspecific inflammatory processes in the skeleton, certain blood diseases that may attack the skeleton, and the osteogeneous sarcomas.

It may often prove difficult to distinguish a primary tumor from an inflammatory lesion in the bone as both have their most usual localization in the long bones, and naturally certain similarities in the clinical picture contribute to the difficulties, e. g. fever, pains, high sedimentation rate, and even the local status. In 2 of our 9 cases the diagnosis of osteomyelitis was made in another hospital. On the other hand, one case was referred to us under the probable diagnosis of Ewing's sarcoma, where we made the diagnosis of bone abscess. As this case (J. Osteomyelitis 1/1938 Radiologic Clinic) has great diagnostic interest, it will be described here more thoroughly.

On August 28, 1938, a 20-year-old labourer met with a bicycle accident and had his left foot squeezed between the pedal and the ground. He lay at home for ten days with a bandage, but as he did not recover he was admitted to his district hospital on the $^{31}/_{8}$. He then presented signs of distortion of his left ankle-joint and as a fibula fracture was suspected, the patient was roentgenologically examined. No injury to the bone was found and the patient was sent home with a supporting bandage. He returned on the $^{17}/_{9}$, complaining of pain and tenderness in the lower leg above the ankle-joint. There was a swelling over the malleoli and on the medial aspect of the tibia an insignificant, diffuse, tender enlargement was palpated. On roentgen reexamination a rounded, welldefined area of destruction of the tibia, the size of a pigeon's egg, was found immediately beneath the lateral cortical outline, one or two cm. above the talocrural joint; some periosteal stratifications were visualized at the level of the destruction. (Fig. 6.) The sedimentation rate (FÅHRAEUS-WESTERGREN) was 96, but as there was no fever, leucocytosis or local signs of osteomyelitis, he was transferred to the Radiological Clinic in Lund under the probable diagnosis of Ewing's sarcoma. On admission another roentgen examination was made; at this, it was observed that the periosteal stratifications had further increased and that two sequestrae of about the size of a hempseed had appeared immediately beneath the cortex. (Fig. 7.) The roentgen diagnosis was therefore osteomyelitis and at operation this diagnosis was verified.

Pathologic Anatomic Diagnosis. — Granulation tissue with abundant infiltration of lymphocytes and plasma cells together with leucocyte accumulations; dispersed necrotic bone fragments; no signs of specific inflammation; no tumor structures.

There are certain differences in the roentgenogram which require discussion. The periosteal stratifications of Ewing's sarcoma are usually

more extensive in the early stages. The destruction is generally of a more central and at the same time more diffusely defined type and a spoon-shaped enlargement of the bone is often seen. In inflammatory processes, at least in their later stages, sequestrae generally appear which does not occur with Ewing's sarcoma.

In our material there has never been any difficulty with the differential diagnosis between Ewing's sarcoma and tuberculosis of the bones. The latter commonly appears meta- or epiphysially as a clear destructive process, but in rare instances it may be found in the diaphysis. The roentgenogram may vary a great deal; sometimes there is seen a central defect with no surrounding sclerosis, but with periosteal stratifications. Thus it may closely resemble the picture of a primary tumor of Ewing's sarcoma and not until the appearance of skeletal metastases will an exact roentgen diagnosis become possible.

In case no. 4 and in another of the following cases we were confronted with the differential diagnosis of Ewing's sarcoma or luetic changes of the bone. The latter may also simulate a primary tumor and this is true of both gummatous necrosis and luetic osteitis. The first mentioned is generally localized to the flat bones and because of the simultaneous appearance of destruction and periosteal reaction differential diagnosis may be extremely difficult. In the gummatous changes the defects are surrounded by a sclerotic outer portion which does not appear in Ewing's sarcoma; in our case, with the primary tumor in the frontal bone, the absence of this sclerosis was the deciding factor in the diagnosis of Ewing's sarcoma.

When luetic osteitis is localized to the long bones, the roentgenogram may strongly resemble sarcoma. In the French literature these cases are named »Pseudosarcome Syphilitique». WESTERMARK and HELLERSTRÖM together have published two of these cases, in which no roentgenological differential diagnosis was possible. Here in Lund we have had a similar case (Surgical Clinic J. 4190/1938), that will be related in detail in order to illustrate the roentgenological diagnosis difficulties.

A young girl 17 years of age complained of slight discomfort in her right knee for one or two days during the preceding summer. About one month before admission to the Surgical Clinic the patient quite accidentally observed an oval, slightly tender, diffusely defined enlargement on the ulnar side of her right forearm, about 1 dm. below the elbow. »The lump» had not increased in size during this interval. There was no pain, discomfort or disability, yet she thought there was a sensation of heat over the enlarged area which was hard when palpated. Did not know of any trauma. Had a bruise just below the enlargement, but thought she had got it later. The patient had taken her temperature

Fig. 8 a.

Fig. 8 b.

Fig. 8. »Pseudosarcome syphilitique». Spool-shaped enlargement of the upper half of the right ulnar diaphysis with extended lamellar periosteal accumulations outside a destruction mainly confined to the cortex.

on several occasions during this month but had had no fever. Otherwise she felt quite sound.

Roentgen examination showed (Fig. 8) a spool-shaped enlargement, the length of a decimeter, of the upper half of the right ulnar diaphysis with extensive lamellar periosteal accumulations outside an area of destruction mainly confined to the cortex. On examination of the skeleton some spot-shaped areas of destruction of the spongiosa were found in the upper part of the right tibial diaphysis and at the same level there was an irregularity of the corticalis due to a small lamellar periosteal accumulation. (Fig. 9.)

Fig. 9.

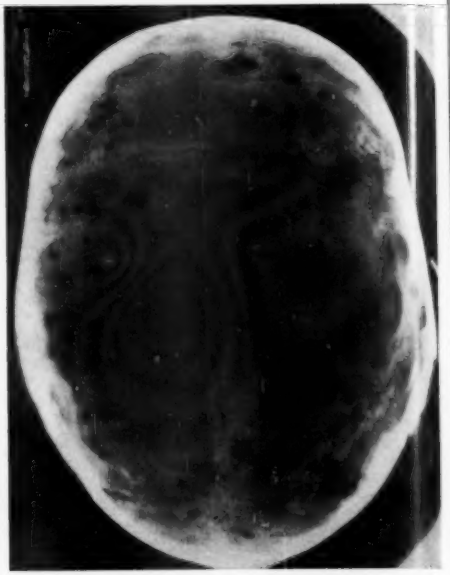


Fig. 11.

Fig. 10.

Fig. 9. Case of lues. In the right tibia diaphysis some spot-shaped attenuations of the spongiosa and on the same level an unevenness of the corticalis, due to a small lamellar periosteal accumulation.

Fig. 10. Case II. Metastases in the skull.

Fig. 11. Preparation picture of the same skull in order to show the distinct limitations of the destructive centres more clearly.

Because of the character of the destruction in the ulna peripherally the picture was not considered to be typical of Ewing's sarcoma and despite the appearance of the skeletal changes in the right tibia there was some doubt of the diagnosis. An excision biopsy (C. G. AHLSTRÖM) showed the following: »The tissue excised from the bone centre of the right forearm shows the picture of chronic inflammation of a specific character. Large extensive necroses of a rather caseous type, surrounded by light epithelioid cells in palisade arrangement are observed. In the surrounding areas small centres of bright epithelioid cells appear here and there. No signs of tumor can be seen. The differential diagnosis lies between tuberculosis and lues, the morphological decision being difficult. The coherent type of the necrosis and the appearance of endarterial changes in places here and there speaks in favour of lues.»

At the continued examination of the patient a positive Wasserman reaction, Hutchinsson's teeth and a parenchymatous keratitis was discovered.

This serves to demonstrate the confusion that may arise in the roentgenological interpretation of bone changes in the presence of lues; in some instances, the picture, in itself, will be inadequate for the differentiation of Ewing's sarcoma and luetic bone lesions.

Further, the bone changes of malignant lymphogranulomatosis and lymphatic leukaemia often roentgenologically resemble that of the primary tumor, but in these diseases as in tuberculous and luetic lesions of the bones it is, in most instances, other facts than roentgen which decide the diagnosis.

Finally, osteogeneous sarcoma may also closely resemble Ewing's sarcoma radiographically and in our material this similarity once caused a wrong diagnosis, while in case no. 6 (Fig. 2) the original diagnosis was osteogeneous sarcoma and only the discovery of skeletal metastases gave the diagnosis of Ewing's sarcoma. A faulty diagnosis such as that is easily explained, when it is remembered that osteolytic sarcomas in their early stages have a more or less central destruction with a simultaneous periosteal reaction, and in the osteoblastic osteogeneous sarcomas the roentgenogram may be such that it will be practically impossible to distinguish them from a primary tumor. It should be mentioned, as general rules, that osteogeneous sarcomas are metaphyseal in location, have a limited extent in the long axis of the bone, contribute to the new growth of the bone and only in rare, exceptional cases metastasize to the skeleton, while with Ewing's sarcoma there is a diaphyseal localization, considerable spread with diffuse transition to normal tissue — thus they embrace more than half the shaft in a short time — a spool-shaped enlargement and early metastases to the skeleton. Yet occasionally even

in these cases it is only the appearance of skeletal metastases that confirms the diagnosis.

Concerning the differential diagnosis of the metastases, the original opinions were that carcinomatous metastases were only found in old people whereas Ewing's sarcoma appeared in young people. With additional experience it is now known that Ewing's sarcoma may appear at all ages though they are definitely more frequent in the first three decades. In 95 % of the cases the age is under 25 years; 5 of our 9 cases are more than 25 years of age, 1 case being 71 years old it therefore should not be forgotten to consider Ewing's sarcoma in cases of even advanced age. Further, there are several cases of carcinoma in our records in which bone metastases have occurred at very early ages and thus age should not be of deciding significance, even if, on the whole, it may point in a certain direction.

Myeloma may also give similar destructive centres and both these and the metastases of Ewing's tumors have a predilection for the skull and vertebrae. It is said that the changes in myeloma are more sharply defined; the following roentgenograms will show that this is not true as regards the skull (Fig. 10, 11 and 12) though the vertebrae (Fig. 13, 14 and 15) in Ewing's sarcoma show a more plastic remodelling in the compression of the vertebral bodies.

The osteolytic giant cell tumors roentgenologically resemble the metastases to a great extent. With giant cell tumors there is sometimes seen in the more advanced stages a characterictic interruption of the cortex with the bone capsule issuing from the outside of the healthy diaphysis at some distance from the actual interruption.

Bone Cysts and Osteitis Fibrosa Generalisata are usually distinguished by the roentgen character of the areas of destruction and by chemical and hormonal studies. In addition, repeated reexaminations reveal a lack of progress in the benign lesions, but they may give a roentgenogram similar to Ewing. Still, if a primary tumor is searched for persistently the diagnosis can be established.

By this method of complete roentgen examination of the skeleton we have succeeded in making the diagnosis of Ewing's sarcoma in 2 cases in which the primary centres did not cause any symptoms and the patient was admitted to the hospital because of symptoms resulting from metastases. These cases are nos. 8 and 9. The former with complaints referable to the left knee-joint region had the primary tumor in the left forearm, the latter with symptoms from the left shoulder joint had the primary tumor in the occipital bone. (Fig. 16, 17 and 18.)

Fig. 12. Myeloma in the skull. Verified case.

Fig. 13. Case II. Metastases in the vertebrae.

Fig. 14. Metastases in another vertebra (preparation picture).

Fig. 15. Myeloma in a body of a vertebra. Verified case.

Fig. 16. Case VIII. Metastases in tibia sin.

Fig. 17. Case VIII. The primary tumor in the left forearm bone.

Fig. 18. Case IX. Metastases in the left forearm body.

Case Reports

Case I. Ingemar L., $1^1/_2$ years old. Journal 1/1931. Radiological Clinic. In June 1931 a soft and elastic enlargement behind the left ear was noted. Admitted to the eye clinic in Lund, where a mastoidectomy was performed. Pathologic Anatomic Diagnosis 1/8/1931 (C. G. AHLSTRÖM): »The biopsy of the tumor in the proc. mast. region shows a malignant tumor, formed of rounded, uniform cells, lying closely together, with a rounded kernel and small chromatin. The tumor shows a quite homogeneous undifferentiated structure; here and there, however, solitary multinuclear giant cells appear. The tumor tissue is traversed by leucocytes and at one single place there is an accumulation of lymphocytes. Several mitoses are observed. The anatomic classification of the tumor is difficult. Quite descriptively it can be classified as a round cell sarcoma, which was the anatomic diagnosis on the occasion of the examination in 1931, but as clinical diagnosis shows a tumor, primary in the osseous system, it should be possible to be more exact. There is no basis for the diagnosis of osteogeneous sarcoma or myeloma. On the other hand the structure of the tumor agrees well with an undifferentiated sarcoma of the Ewing type.»

The patient was then transferred to the Radiologic Clinic; the left regio mastoidea appeared to be the seat of an operative wound which was gaping and secreting a great deal of greyish-brown pus. Roentgenological treatment of the ear was administered and the wound healed. In September 1931 the patient returned with a metastasis in the left scapula, in May 1932 with metastases in his pelvic girdle, in September the same year with metastasis in the right femur, and in Oktober 1933 with metastasis in the right kidney (Fig. 19).

On every occasion his symptoms rapidly disappeared with radio-therapy and with the roentgen follow-up it was possible to follow the diminution in the size of the destructive centres in the skeleton while the bony structure regained its normal density.

The patient is still alive, and is sound and healthy.

Case II. Sonja F., 13 years old. Journal 1/1933. Radiological Clinic. In the spring of 1932 noted occasional pain and discomfort in the left groin region. At the beginning this appeared at intervals of months and lasted for only one or two days. It was always connected with elevation of temperature to 38°. Gradually the symptoms returned more often and remained longer. At the end of March 1933 the patient had a node-shaped enlargement of the left groin and as this rapidly increased in size she was admitted to the district hospital in the middle of April where she was treated for 6 weeks under the diagnosis of chronic osteomyelitis. Roentgen examination on admission showed periosteal stratification on ramus superior ossis pubis sin. No evidence of sequestrum. During her stay in the hospital the patient had fluctuating temperature. The high temperature occurred every 4th or 6th day and sometimes was as high as 39°,5. The mass in the groin disappeared completely, but at the end of May the patient had radiating pains in the loin and a slowly increasing protrusion of the left eye-bulb.

Because of the constant down hill course the patient was admitted on the $^7/_7$ to the medical clinic in Lund.

At the roentgenological examination 4 days later multiple destructive centres were found in the skull, the spine, the pelvis and the proximal parts of the two thigh bones. The previously observed pathological changes of os pubis sin. also appeared. They were quite different from the above described ones. There appeared an elongated irregular area of destruction in the bone, deleting the normal cortical outline, and there were well marked periosteal lamellae in a stratified arrangement all along the ramus.

(Fig. 1.) — For that reason the roentgenological result should be pathognomonic of EWING's sarcoma.

The patient's lesion was very radiosensitive, but on the $^{6}/_{8}$ the patient died cachectico modo.

The following day an autopsy was performed; Las. obd. 359/1933.

Pathologic Anatomic Diagnosis: EWING's sarcoma (probably primary in os pubis and with metastases in the vertebral column, the skull, the liver and the spleen).

Microscopic examination (A. LINDAU): Os pubis: in the marrow cavities there is in part rather fibrous normal bone marrow but in other parts an abundant tumor infiltration with quite small, rounded, uniform cells. No clear differentiation with vascular cavity. In extensive portions there is necrosis of the tumor. The bone tissue is rarefied. In *the bodies of the vertebrae* a similar picture is seen: the bone tissue is rarefied to a high degree and only thin buckles of bone remain. Here the tumor tissue is uniform; no differentiation of the intercellular substance, but a slight tendency to a perivascular arrangement. The *dura* is not embedded by tumor except for some thin streaks along the vessels. The attached tumor is almost completely necrotic and only adjacent to the dura can the structure (the same as that of the bone system) be discerned. The soft parts of *the true pelvis*, covering os pubis, show invasion by necrotic tumor tissue. *The liver metastases* are very well delimited from the parenchyma and show the same structure as that described for the tumor of os pubis; fairly numerous mitoses occur.

Fat staining negative. *The spleen* shows scattered centres of the same type as the liver metastases.

Case III. Karl P., 54 years old. Joiner. Journal 2/1933. Radiological Clinic. In February 1933 noted a steady continual ache below right knee-joint. It gradually increased, and in the middle of March the patient discovered a callosity above the right knee-joint. As the enlargement increased in size the patient was admitted to his district hospital at the beginning of April, where he was treated for 3 weeks. Clinically and roentgenologically the diagnosis of chronic osteomyelitis was given. No incision was performed. The patient had been told to return to the hospital after 6 weeks. But though the enlargement of his right thigh and the ache increased considerably, he did not appear until the end of July. At this time he could hardly place his weight on his right leg because of pain and soreness, but when he was informed at the consultation that it was a question of an operation, he left the hospital immediately. Then he stayed at home until the middle of September, though his distress increased so much that at last he could not stand up.

On the $^{13}/_{9}$ 1933 the patient visited the surgical polyclinic in Lund, and was admitted at once. He presented a spool-shaped enlargement of the lowest part of the right thigh bone, double the size of a palm and hard as bone. In the right groin some firm glands were palpated, which were freely movable and of which the biggest was the size of a dove's egg.

At roentgen examination there was found in the central and distal parts of the right femoral diaphysis an extensive irregular destructive process, here and there alternating with sclerosis, and extensive lamellar periosteal stratifications; multiple destructive centres in os ileum and in the left thigh bone were observed (Fig. 20, 21 and 22).

The roentgen report agreed with EWING's sarcoma and biopsy of a gland from inguinal region showed: (Pathologic Anatomic Diagnosis 2454/1933 [A. LINDAU]) complete obliteration of the normal structure and one sees an undifferentiated tumor tissue built up of bright, rounded, »endothelial» cells. Numerous mitoses, no connective tissue formation to speak of, no periosteal arrangement. Fat staining positive only in a few cells. Does not resemble cancer, hypernephroma, or osteogeneous sarcoma. Diagnosis: Malignant tumor (possibly an EWING's sarcoma).

Fig. 19. Case I. Metastases in the right kidney.

Fig. 20. Case III. The primary tumor in the right thigh bone with elongated central diffuse defined destruction and lamellar periosteal stratifications.

Case IV. Anna Ö., 71 years of age. Journal 3/1933. Radiological Clinic. At the end of August 1933 the patient found it difficult to put on her hat and she discovered she had a bump on her forehead. This increased in size and as she found she had a little node in the neck too, she visited a physician who sent her to the surgical clinic in Lund.

On the middle of the forehead a rounded, circumscribed, well defined convexity, the size of a goose egg and of firm consistency was found. At roentgen examination of the cranium a defect of the shape of a watch glass and of a diameter of 3 cm. was observed. The destruction traversed the whole of lamina externa and invaded diploe. In the defect very thin periosteal stratifications occurred (Fig. 3). Several ball-shaped densities up to the size of a plum in both lung fields with an appearance characteristic for tumor metastases were found. (Fig. 23.) Roentgenologic diagnosis: EWING's sarcoma.

To prove this diagnosis the cervical gland was extirpated for pathologico-anatomic examination. Pathologic Anatomic Diagnosis 2514/1933 (J. FORSSMAN): The extirpated gland shows a malignant infiltrating tumor consisting of rounded up to slightly spool-shaped cells; on the whole, a myxo-cellular sarcoma.

At reexamination of the preparation, it was considered that it could agree with the picture of an EWING's sarcoma.

The patient was transferred to the Radiological Clinic where roentgenological treatment to the primary tumors and the metastases was administered. The enlargement on

Fig. 21. Case III. Metastases in os ilium.

Fig. 22. Case III. Metastases in the left thigh bone.

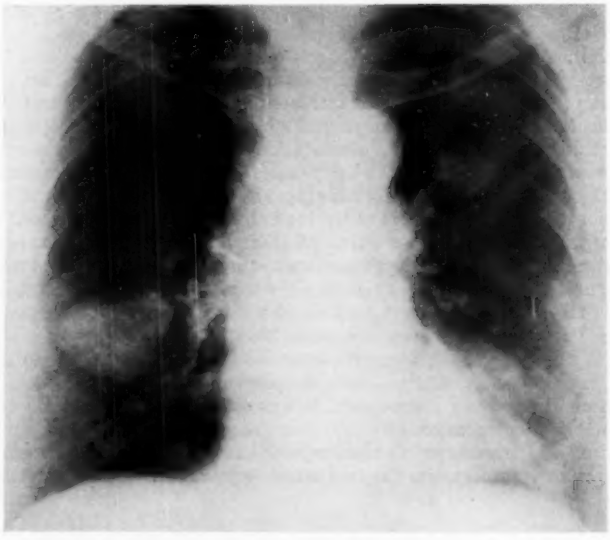


Fig. 23 Case IV. Metastases in both lung fields.

e forehead disappeared completely and the lung metastases receded rapidly, but never isappeared completely.

After several months the patient had a metastasis in the sternal end of the left avicle. This also receded rapidly after roentgen therapy, but on the $^{21}/_{12}$ 1934 the patient ed at home. No autopsy was performed.

Case V. Einar P., 34 years of age. Joiner. Journal 1/1935. Radiologic Clinic. the end of December 1933 tired and faint and in the middle of January 1934 a grinding he in his left thigh; at the beginning this was only during strain, but from the middle March there was a constant ache. The discomfort constantly progressed and in April s so pronounced that the patient could no longer work. He consulted a physician ho diagnosed sciatica. In spite of lying in bed, salicylate medication, bathing etc. the mptoms increased. The ache became radiating and on the $^{20}/_{10}$ 1934 the patient was mitted to the rheumatic department in Lund. He had been subfebrile.

On admission a mass below the left trochanteric region was found, firm against the one beneath and slightly tender to palpation.

The roentgen examination showed a dissolution of the bone structure in the upper half of the diaphysis of the left femur, usuration of the cortex and elongated lamellar periosteal stratifications. There was also a small destructive centre in the right thigh bone, and the roentgenologic diagnosis was EWING's sarcoma.

The patient was transferred to the surgical clinic for biopsy.

Pathologic Anatomic Diagnosis (C. G. AHLSTRÖM): The tissue from the tumor in the left trochanteric region shows tumor composed of medium-sized, closely lying cells with a rounded nucleus and minute chromatin. Distinct cell limits cannot be discerned and the cells seem to be syncytially connected with one another. The tumor tissue has an undifferentiated character and appears as an even mat of cells in which here and there streaks of connective tissue can be discerned. Several mitoses. There is no differentiation of osteogenic tissue and no formation of reticular fibrils. Pronounced infiltration into the surrounding musculature can be noticed. It is a case of EWING's sarcoma of typical structure.

The patient received roentgen treatment to the primary centre and metastases and improved considerably. His pains disappeared, the resistance decreased in size and the patient was able to be up and about fairly well.

In the middle of May 1935 his left eye suddenly swelled and the patient had a slight protrusion of the bulb. One or two weeks later the patient had a spontaneous fracture of his right humerus where an osteolytic metastasis was discovered.

By roentgen examination a lung metastasis was found to exist and on the $^{4}/_{8}$ 1935 the patient died.

Case VI. Klas O., 14 years of age. Journal 2/1936. Radiological Clinic. In March 1936 the patient tumbled down the stairs and hurt his left calf. Was able to lean on his leg but was away from school the following days because of ache in his leg. Gradually the pain diminished, but did not disappear completely and as it was more pronounced in April, he consulted a physician who ordered fomenting bandages and rest in bed. As the ache did not disappear in spite of this and the patient himself noticed that the lower leg increased in size, he was admitted to his district hospital at the end of May. Roentgenological examination revealed a destruction of the proximal part of the shaft of the fibula with spiculae in the centre of the defect and lamellar periosteal accumulations above and below. Biopsy from the soft parts showed that it was round cell sarcoma and therefore the patient was transferred to the Radiological Clinic in Lund. On reexamination here the diagnosis of osteogenic sarcoma was made. On the proximal part of the

fibula a spool-shaped enlargement of almost 10 cm. was found. In the medial and anterior extent of the enlargement a vaguely defined pit-shaped defect of a length of 6 cm was seen. From the inferior portion of the defect several spiculae were issuing. Above and below the defect the periosteum was raised with lamellar periosteal stratifications. Laterally convex bending of the fibula at the level of the defect (Fig. 2). — In the remainder of the skeleton there were no signs of metastases, and the roentgenological diagnosis was osteogeneous sarcoma. The patient was transferred to his district hospital where amputation of his left leg was performed. After this the patient was perfectly sound until the beginning of March 1937 when pains in the back began. The patient was roentgenologically examined and a metastases in the 4th lumbar vertebra was found. Because of this the case was reviewed and at reexamination of the pathological preparation the following was diagnosed:

Pathologic Anatomic Diagnosis. 1985/1936. (C. G. AHLSTRÖM): The tumor in the left fibula shows a typical picture of EWING's sarcoma; it is formed of medium sized cells, lying closely together with rounded nucleus and a small amount of chromatin. Fairly numerous mitoses are observed. The tumor cells form compact, undifferentiated streaks or appear as an even mat of cells, but in several places show by interspersed streaks of connective tissue an irregular alveolar arrangement. Numerous vessels are perceived in the tumor tissue.

The patient was therefore sent back to the Radiologic Clinic for roentgen therapy. During the treatment he had double vision and at roentgen examination of the cranium multiple areas of destruction were noticed. Metastases in the pelvic girdle and the right femur were also found. Improved considerably during the roentgen treatment and on the roentgenogram as sclerosis of the vertebral metastases and a disappearance of the bony metastases of the skull was observed.

In December 1937 a protrusion of his right eye-bulb and an enlargement of the right temple region began. Roentgen treatment appeared to be ineffective and on the $^{17}/_{2}$ the patient died.

Case VII. Artur S., 29 years old. Accountant. Journal 1/1937. Radiologic Clinic. At the end of December 1935 ache in his right hip. Treated for 2 weeks at his district hospital under the diagnosis of sciatica. Was examined roentgenologically. The roentgenogram was interpreted as normal, but at the reexamination a slight decalcification of trochanter major was observed. — Free from complaints until the end of October 1936, when the patient had aching pains in his right hip again and lay for 2 weeks in the same hospital. Discharged free from symptoms after the usual sciatica treatment. Had one or two more periods of ache in his hip. These were now connected with slight elevations of the temperature. At the end of March 1937 he was roentgenologically examined once more and as a pronounced decalcification of trochanter major and the lateral part of collum femoris dx was found, the patient was sent to a seaside sanatorium under the diagnosis of bone tuberculosis.

On arrival on the $^{10}/_{4}$ 1937, the right glutealfold was found to be levelled out to a great extent and laterally a bulging, osseous resistance as big as a fist was palpated, extending towards the trochanter. A roentgenological examination the same day showed destruction of the bone in the hinder and upper regions of trochanter major, affecting fossa intertrochanterica and the hinder part of collum. Posteriorly and laterally lamellar periosteal stratifications appeared and thus the picture at this early stage well agreed with the primary tumor of an EWING's sarcoma. At repeated roentgenological examinations the increase of these stratifications could be followed, while the destruction remained about the same. All this time, the patient had had periods of violent pains in his right hip.

In the middle of August a biopsy was performed. Pathologic Anatomic Diagnosis. 2713/1937 (ALF SJÖVALL). The biopsy of the tumor of the upper part of the femur showed a malignant tumor built up of uniform cells in homogeneous, monotonous arrangement. Several mitoses. Giant cells were missing; no signs of osteogenesis or arrangement of collagenous connective tissue. From the histological point of view the tumor is of the sarcoma type and of the sarcomas, if we start from the bony system, it is most likely to be an EWING's sarcoma.

The patient was transferred to the Radiological Clinic in Lund for roentgen treatment and on admission another roentgenological examination showed a considerable destruction of the right hip joint region which extended from the collum femoris down to the upper part of the shaft. Along the upper part of the diaphysis in a region of the length of a decimeter, periosteal accumulations extending parallel to the cortical outline were noticed, being most pronounced laterally and corresponding posteriorly to the region of maximal destruction.

There were defects of os parietale probably caused by tumor metastases, a pronounced rarefying of the structure and small spot-shaped attenuations of corpus ossis ilei dx.

After the roentgen treatment the patient rapidly improved and follow-up examination has shown that he is still free from symptoms.

Case VIII. Ingegärd H., 13 years old. Journal 1/1936. Radiological Clinic. At the age of 11 symptoms from the left knee-joint region in form of slight pains and diffuse discomfort. On the $^{24}/_{8}$ 1935 — the patient was by then 13 years old and had had her pains for $1^{1}/_{2}$ years — she suddenly had such severe pains in her left knee that only with difficulty was she able to lean on her leg. She was now sent to the district hospital where an enlargement, increase of heat and extreme tenderness over the upper part of the tibia were found. Roentgen examination on admission showed extensive bone destruction that embraced the anterior part of the tibia almost in its whole breadth in a region larger than a mandarin-orange. The destruction reached the level of the joint and yet the joint was not involved. (Fig. 16.)

The probable diagnosis was giant cell sarcoma, and the patient received roentgen treatment during which time she improved rapidly. In the beginning of May 1936 pains in her left shoulder region and enlargement of the right zygomaticus region. She was therefore admitted to the roentgenological clinic in Lund for consultation.

At roentgenologic examination here, destructive centres of the proximal part of the left tibia, skull and os zygomaticum dx were seen, as well as destructive process localized to the left upper humerus, nearly the length of a decimeter, connected with elongated lamellar periosteal stratifications. (Fig. 17.) There was also a ball-shaped metastasis in the base of the right lung field.

The picture thus agreed with the diagnosis of EWING's sarcoma, the changes of the proximal part of the left humerus being interpreted as the primary tumor.

The patient's symptom rapidly receded under roentgen treatment, but later, she had metastases both in the femur and in the pelvis and in January 1937 she died.

Case IX. Gunnar K., 28 years of age, unskilled labourer. Journal 241/1937. Medical Clinic.

In October 1936 ache in his left shoulder-joint for one or two days. He connected this with trauma to the shoulder in July 1936, though the ache in October occurred without special cause. The week before Christmas he had another period of discomfort and as at the beginning of January he had aching pains in his shoulder again and pains in the lumbar region and right hip, he consulted a physician who diagnosed polyarthritis rheumatica and referred to the medical clinic in Lund.

On admission the patient had a subfebrile temperature. The sedimentation rate (FÅHRÆUS-WESTERGREN) was 78/115 mm. and he complained of great discomfort. As this did not diminish under the usual polyarthritis treatment, but increased instead, especially in the left shoulder-joint, and the temperature, pulse and sedimentation rate rose, the patient was at the end of January 1937 roentgenologically examined. A dissolution of the bony structure, about the size of a hazel nut was discovered in the caput humer sin. (Fig. 18.) On this account the whole skeleton was roentgenologically examined and destructive centres in skull, vertebrae and pelvis girdle were found. One centre in os occipitale sin. showed on picture in tangential ray direction a periosteal reaction in the form of small lamellae at the limit of the destruction and spicula formation centrally (Fig. 4).

The roentgenological diagnosis was EWING's sarcoma, with the primary tumor in the left occipital bone.

Roentgen treatment of both primary centres and metastases was started, but no result was obtained either subjectively or visibly on radiogram. On the contrary the patient's pains were intensified. Thus he often had periods of violent pains connected with high temperature which appeared more and more often, and at the beginning of January 1938 the patient died.

SUMMARY

The author describes the typical features of the roentgenogram of the primary EWING tumors. It is generally only the combination of the typical radiogram of the primary tumor and the radiogram of the skeleton metastases that can give an exact roentgendiagnosis. Therefore a complete examination of the whole skeleton of the person has to be made. With the luetic bone changes not even this is sufficient, as the author shows in one case.

In the differential diagnostic of the metastases of EWING sarcomas the author lays stress upon the fact that such metastases, when localised to the vertebrae bodies, give to these a kind of plastic remodelling and not a mere compression as in myeloma.

A short account is given of the 9 cases of EWING sarcoma treated at the Lund clinic in the years 1932—1938, of which 7 have pathologico-anatomical verification. In the other two cases roentgenogram, clinical picture and course of the disease have been such that there has been no doubt about the diagnosis.

ZUSAMMENFASSUNG

Verf. beschreibt die typischen Züge der Röntgenogramme von primären Ewing-Tumoren. Gewöhnlich können nur die typischen Radiogramme des Primärtumors und die Radiogramme der Skelettmetastasen zusammengehalten eine exakte Röntgendiagnose geben. Aus diesem Grunde ist eine vollständige Untersuchung des ganzen Skeletts des betreffenden Patienten vorzunehmen. Bei den luetischen Knochenveränderungen ist, wie Verf. in einem Fall zeigt, nicht einmal dies genügend.

Betreffs der Differentialdiagnostik der Metastasen von Ewing-Sarkomen legt Verf. Gewicht auf die Tatsache, dass solche Metastasen, wenn sie in Wirbelkörpern lokalisiert sind, diesen eine Art von plastischer Ummodelierung geben und nicht nur eine Kompression wie bei Myelomen.

Verf. gibt einen kurzen Bericht über 9 in den Jahren 1932—1938 in der Lundens r Klinik behandelte Fälle von Ewing-Sarkom, von welchen 7 pathologisch-anatomis h verifiziert wurden. In den anderen beiden Fällen waren Röntgenogramm, klinisch s Bild und Verlauf der Krankheit derart, dass kein Zweifel über die Diagnose bestan .

RÉSUMÉ

L'auteur décrit les traits caractéristiques du roentgenogramme des tumeurs primaires d'Ewing. En général, seule la combinaison du radiogramme typique de la tumeur primaire et du radiogramme des métastases squelettiques permet d'établir un roentgendiagnostic exact. En conséquence, il y a lieu de procéder à un examen complet de l'entier squelette du sujet. Cela ne suffit même pas, comme le montre l'auteur dans un cas, lorsqu'il s'agit d'altérations osseuses syphilitiques.

En ce qui concerne le diagnostic différentiel des métastases des sarcomes d'Ewing, l'auteur insiste sur le fait que de telles métastases, lorsqu'elles sont localisées aux corps vertébraux, occasionnent chez ces derniers une sorte de remodelage plastique et non pas une compression seule comme dans les myélomes.

L'auteur donne un bref exposé de 9 cas de sarcomes d'Ewing traités à la clinique de Lund en 1932—1938, dont 7 furent pathologo-anatomiquement vérifiés. Dans les deux cas restants, la roentgenogramme, le tableau clinique et l'évolution de la maladie furent tels, qu'aucun doute ne subsista au sujet du diagnostic.

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FROM THE LIGHT THERAPY-DEPARTMENT, ODENSE AMTS OG BYS SYGEHUS, ODENSE, DENMARK. CHIEF: P. JACOBY

THREE-PHASE HIGH POWER ARC LAMP FOR LOCALIZED FINSEN TREATMENT[1]

by

Axel Saugman

August 1937, I was asked by my chief, dr JACOBY, whether I could undertake the design of an arc lamp, similar to the FINSEN-LOMHOLT lamp. Accordingly, I worked out the requirements of such an instrument and the available possibilities.

A. The intensity of light must be very considerable.

This may be obtained:

I. By *concentration* through a *lens system*, as used by FINSEN, and, later on, by LOMHOLT.

II. By *concentration* by a *spherical* or *elliptical mirror*, or, better still, by *the combination or Margin mirror and a single lens*. This is the optically most perfect solution of the problem, when a point-source of light is used.

III. By *close approximation of the source of light to the skin*, as used by KROMAYER in his water-cooled mercury lamp.

B. The greater part of the heat must be eliminated, either

I. *Between the light source and the skin*, that is, by *filtering*, or

II. *By direct contact cooling of the surface under treatment.*

Both methods have been originated and used by FINSEN. The filtering principle has been further elaborated by LOMHOLT. It is stated by him, that *colour filters* are necessary, in order to avoid burns, when using light of great intensity. Quite high intensities are, however, well tolerated, if

[1] Paper read before the Northern Association for Medical Radiology, at the meeting in Copenhagen, June 1938.

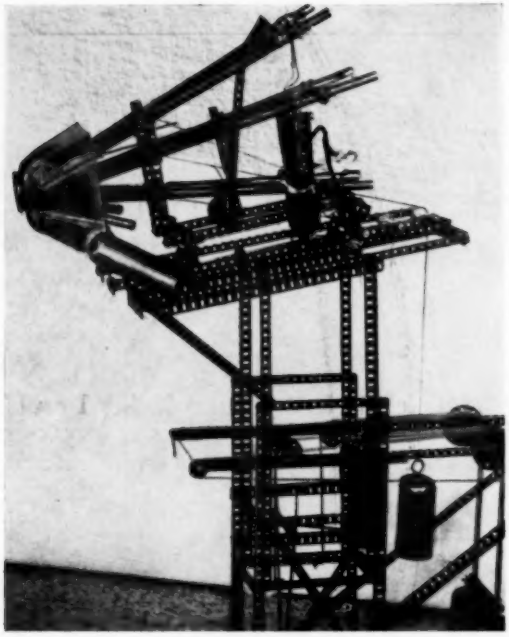

Fig. 1.

a really efficient water-cooling only is used, as shown by experiments at our clinic.

Obviously, the simplest design will be a powerfull arc lamp, closely approximated to the FINSEN compression cup, which will be necessary in order to obtain a proper anemisation.

After a few preliminary tests, a lamp, built on these lines, was demonstrated before the Danish Radiological Society, march, 1938. On this occasion I stated, that this lamp seemed able to produce similar skin reactions, using a treatment time of one minute, to those obtained by a treatment of one hour with the FINSEN-LOMHOLT lamp. Later on, however, I have in several cases, had to use doses of 2 or (in a few cases) even 3 minutes.

The treatment times, 1—3 minutes, seemed extremely short, even taking the very powerfull arc lamp (70 amp. three-phase) and the close approximation (6—8 centimetres focus-skin distance) in account.

This very quick action was supposed by dr. LOMHOLT to be due to a great amount of the short-wawed, destructive, rays of very little penetration, at about 2,500 Ångström. Accordingly, I replaced the rock crystal slab in the compression cup with one of blauuviol glass, which has a cut-off at 2,800 Ångström and an appreciable absorbtion even at 3,000 Ångström.

As it was not even necessary to double the time to get the same results, the influence of the short-wawe rays cannot be predominant. The blauuviol glass, however, has the merit of absorbing a considerable amount of the heat rays.

Therefore, it is in this way possible, by using greater intensity, to compensate for the increased absorbtion losses.

This has been utilised in our present lamp, a 130 amperes three-phase flame arc lamp.

The blauuviol glass is now fitted a few millimetres behind the rock crystal compression slab, and is surrounded by the cooling water stream, which flows at a rate of 42 litres per minute.

We can now reduce our focus-skin distance to about 3 centimetres, and if the compression cup is firmly applied (as it must be), the patient does not feel even the slightest sensation of heat.

At 130 amperes, the optimal dose for the treatment of lupus vulgaris seems to be 1—2 minutes. The field size is 14 sq. centimetres.

Owing to the blauuviol filter, the spectral distribution is very similar to that obtained by the FINSEN-LOMHOLT filter, and a similar depth dose may probably be expected.

Whether it is better to use great intensity and short time, or lesser intensity and longer time, cannot be determined, till extensive clinical investigations have been carrid out.

Our experiences with this lamp, extending over four months only, does not permit of any conclusions as to its therapeutic value. The ability to heal lupus vulgaris is beyond doubt, but no one is able to tell anything concerning the percentage or duration of results till after an observation time of several years.

SUMMARY

A three-phase 130 amperes, condenserless, arc lamp for localized FINSEN treatment, with a filter of blauuviol glass, and a field size of 14 sq. centimetres is described. The dose for treatment of lupus vulgaris is given at 1—2 minutes.

Owing to the limited time, in which the lamp has been used clinically, the author does not yet feel justified to draw any conclusions regarding the obtainable therapeutic results.

ZUSAMMENFASSUNG

Verf. beschreibt eine dreiphasige, 130 Ampere starke, kondensatorlose Bogenlampe für lokalisierte Finsenbehandlung mit einem Filter von blauviolettem Glas und einer Feldgrösse von 14 cm². Die Behandlungsdosis für Lupus vulgaris wird in 1—2 Minuten gegeben.

In Anbetracht der kurzen Zeit, in der die Lampe bisher klinisch in Verwendung gewesen ist, hält Verf. sich noch nicht für berechtigt, irgendwelche Schlüsse in bezug auf die erreichbaren therapeutischen Resultate zu ziehen.

RÉSUMÉ

L'auteur décrit une lampe à arc pour courant triphasé 130 Ampères, sans condensateur, avec un filtre de verre. Blauuviol, et une dimension de champ de 14 cm². La dose pour le traitement du Lupus vulgaris est administrée pendant 1 à 2 minutes.

En raison du temps restreint pendant lequel la lampe à été cliniquement employée, l'auteur ne se considère pas encore autorisé à tirer des conclusions quelconques au sujet des résultats thérapeutiques obtenables.

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